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Planetary Size Comparisons: **FOR REFERENCE**
A Photographic Study

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Stephen Paul Meszaros

JANUARY 1985

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NASA Technical Memorandum 85017

Planetary Size Comparisons: A Photographic Study

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National Aeronautics
and Space Administration

Scientific and Technical
Information Branch

1985

PLANETARY SIZE COMPARISONS:
A PHOTOGRAPHIC STUDY

by
Stephen Paul Meszaros

ABSTRACT

Over the past two decades NASA spacecraft have visited many of the planets and moons of the solar system. During these missions many detailed photographs were taken. This publication utilizes some of the best of the photos to show size comparisons—to scale—of these planets and moons.

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PLANETARY SIZE COMPARISONS: A PHOTOGRAPHIC STUDY

INTRODUCTION

Over the past two decades NASA spacecraft have visited many of the planets and moons of the solar system. Out of these missions has come a wealth of scientific data and detailed photographs. Accurate size measurements of the planets and moons, and their surface features, is one of the most basic types of information to result from this exploration program.

The planetary global views presented in this publication are displayed at the same scale, in each picture. This will allow size comparisons to be done visually. Additionally, special geographical features on some of the planets are compared with selected Earth areas, again at the same scale. In a few cases artist renderings and estimated sizes are used for worlds not yet reached by spacecraft.

Included with each picture is an "H" and/or "HC" number designation. These numbers may be used in ordering copies of the photos. ("H" indicates that the picture is available in black and white, "HC" indicates that it is available in color. Some photos are available both ways).

For information contact:

Audio-Visual Branch (Code LFD-10)

National Aeronautics and Space Administration

Washington, D.C. 20546.

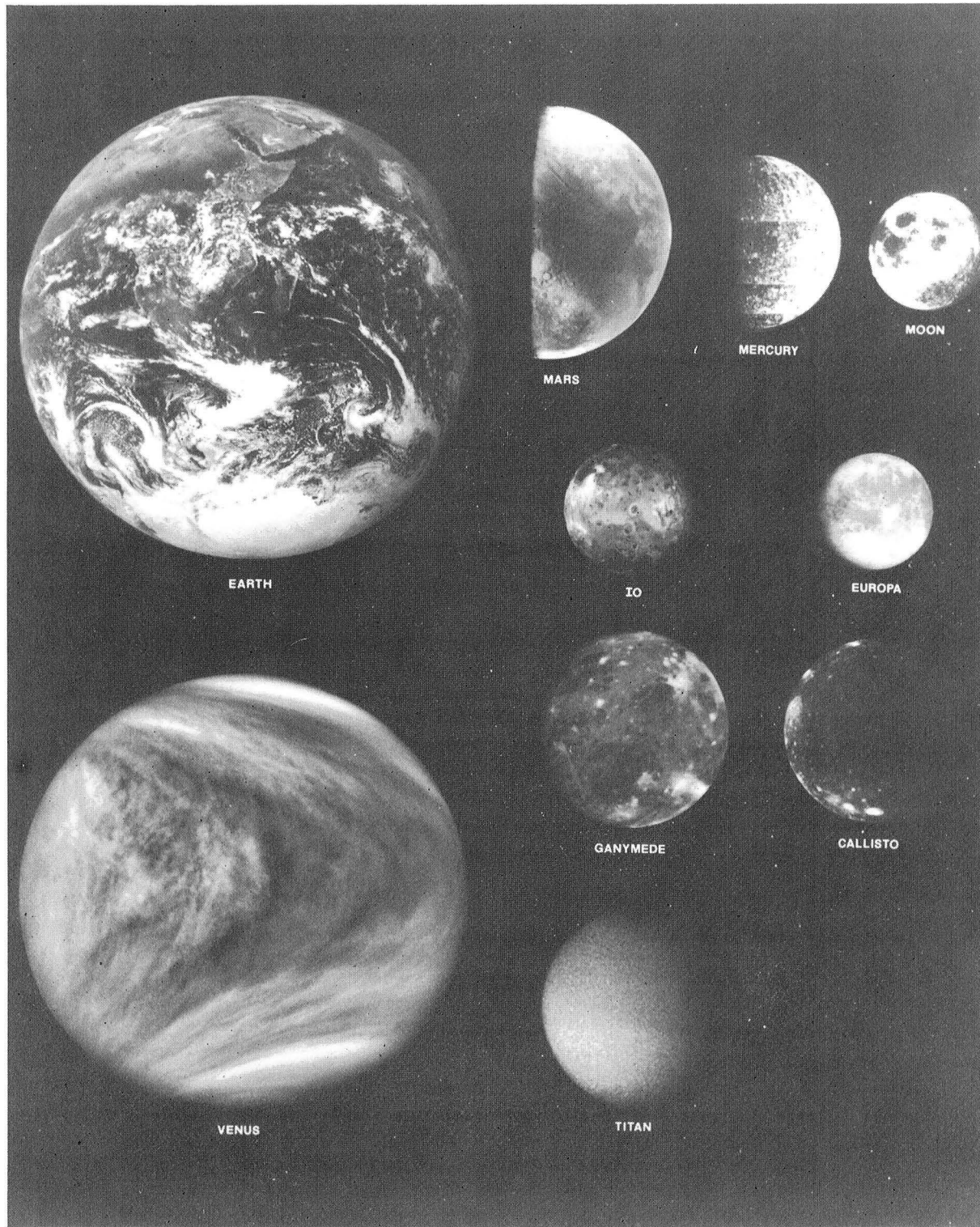
PART I: GROUP COMPARISONS

PLANETS AND MOONS

This montage of photographs taken by various NASA spacecraft displays smaller planets and larger moons of the solar system at the same scale. The inner planets Mercury, Venus, Earth, Mars, and the Earth's moon are shown, as well as Jupiter's large satellites Io, Europa, Ganymede, and Callisto, and Saturn's large moon Titan.

Diameters

Earth:	12,756 kilometers (7,927 miles)
Venus:	12,104 kilometers (7,521 miles)
Mars:	6,796 kilometers (4,223 miles)
Mercury:	4,878 kilometers (3,031 miles)
Moon:	3,476 kilometers (2,160 miles)
Io:	3,632 kilometers (2,257 miles)
Europa:	3,126 kilometers (1,942 miles)
Ganymede:	5,276 kilometers (3,279 miles)
Callisto:	4,820 kilometers (2,995 miles)
Titan:	5,150 kilometers (3,200 miles)

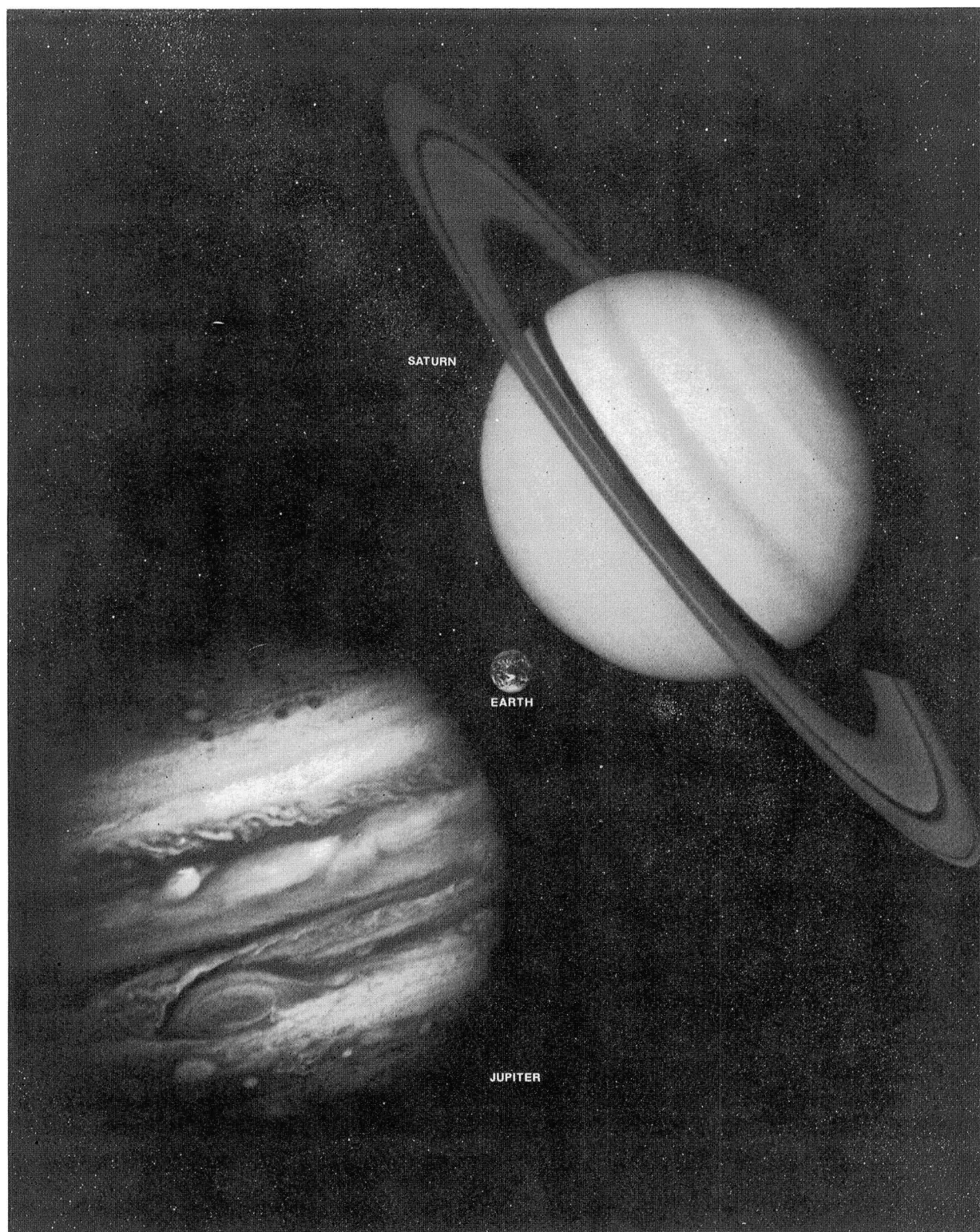


GIANT PLANETS

The solar system's two largest planets are compared with the Earth in this photo montage. Unlike the Earth, Jupiter and Saturn are gas giant worlds composed primarily of hydrogen and helium.

Diameters

Jupiter:	142,796 kilometers (88,733 miles)
Saturn:	120,660 kilometers (74,978 miles)
Earth:	12,756 kilometers (7,927 miles)

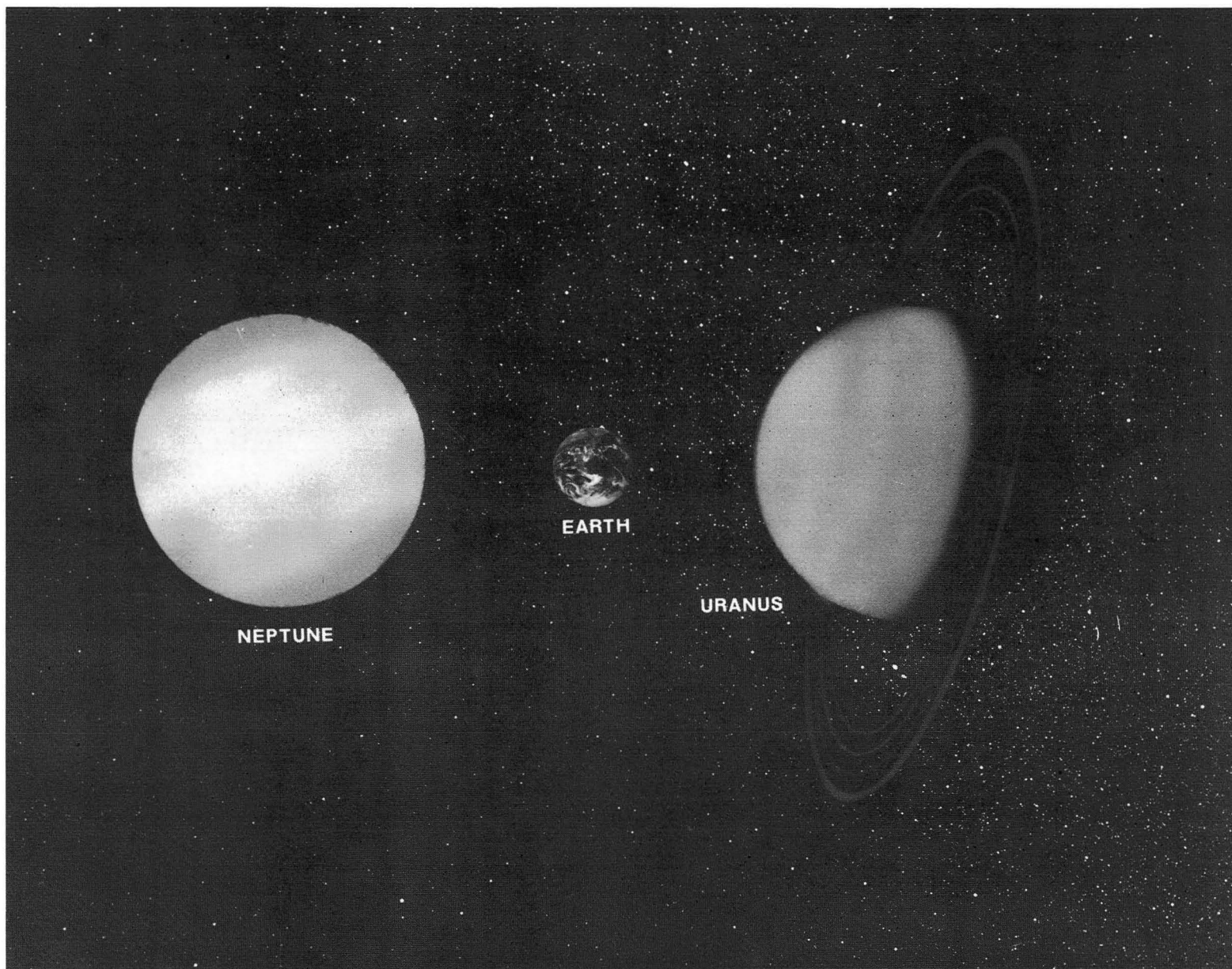


LARGE PLANETS

The large planets Uranus and Neptune are shown at the same scale as the Earth. Since they are very distant worlds and no spacecraft has yet reached them, these are artist's concepts of the way we believe they would appear.

Diameters

Uranus:	50,800 kilometers (31,567 miles)
Neptune:	48,600 kilometers (30,200 miles)
Earth:	12,756 kilometers (7,927 miles)

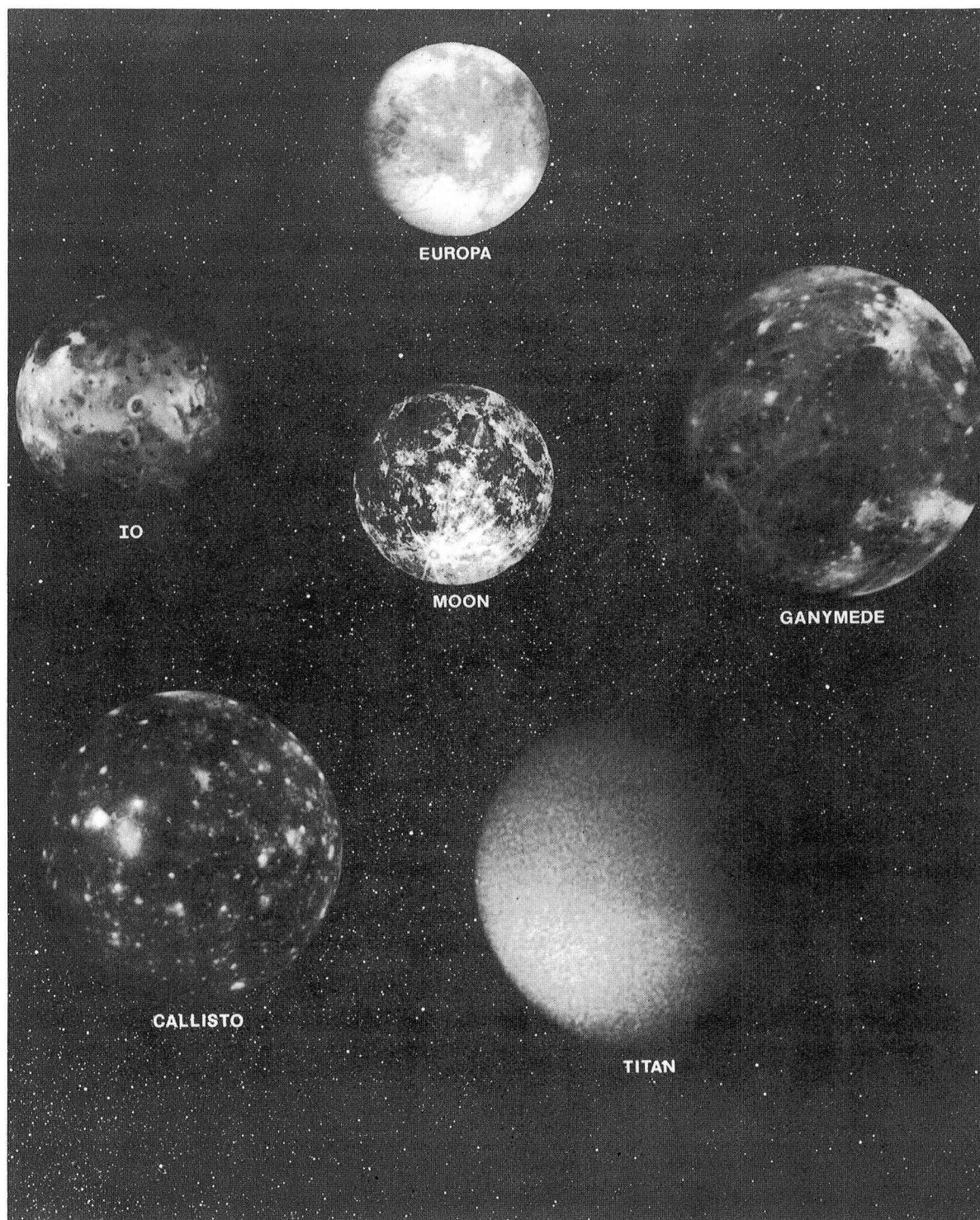


LARGE MOONS

The large moons of the solar system that have been photographed by NASA spacecraft are shown in this montage. Earth's moon, with a diameter of 3,476 kilometers (2,160 miles), is shown at the center. Io, Europa, Ganymede, and Callisto are satellites of Jupiter; Titan is a satellite of Saturn. Ganymede is the largest, with a diameter of 5,276 kilometers (3,279 miles). (Photo of Earth's moon courtesy of Lick Observatory).

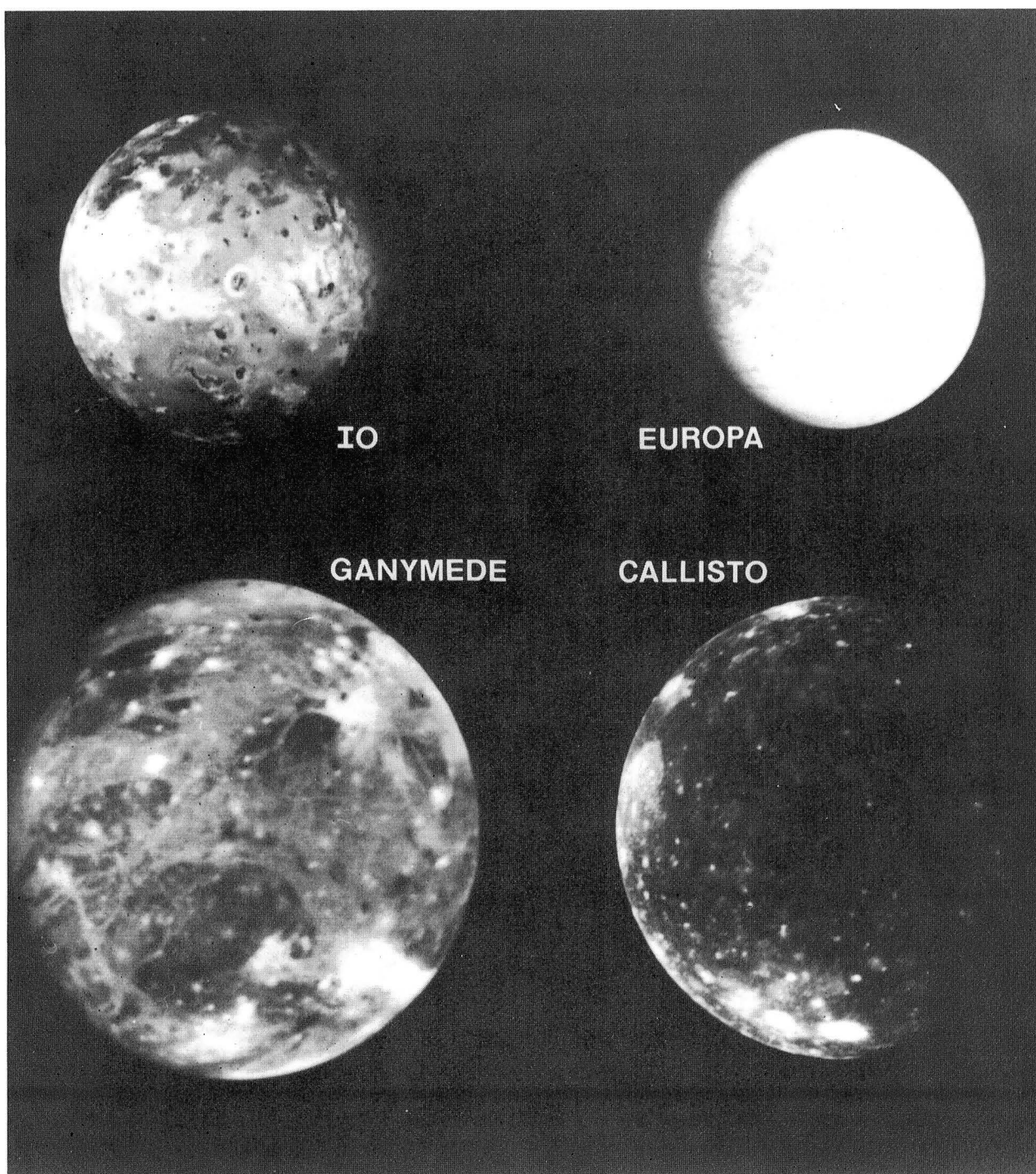
Diameters

Moon:	3,476 kilometers (2,160 miles)
Io:	3,632 kilometers (2,257 miles)
Europa:	3,126 kilometers (1,942 miles)
Ganymede:	5,276 kilometers (3,279 miles)
Callisto:	4,820 kilometers (2,995 miles)
Titan:	5,150 kilometers (3,200 miles)



MOONS OF JUPITER

This is a composite photograph showing the different appearance of each of Jupiter's four largest moons. They are shown approximately to scale, the diameters being: Io, 3,632 kilometers (2,257 miles); Europa, 3,126 kilometers (1,942 miles); Ganymede, 5,276 kilometers (3,279 miles); and Callisto, 4,820 kilometers (2,995 miles). For comparison, the diameter of Earth's moon is 3,476 kilometers (2,160 miles).



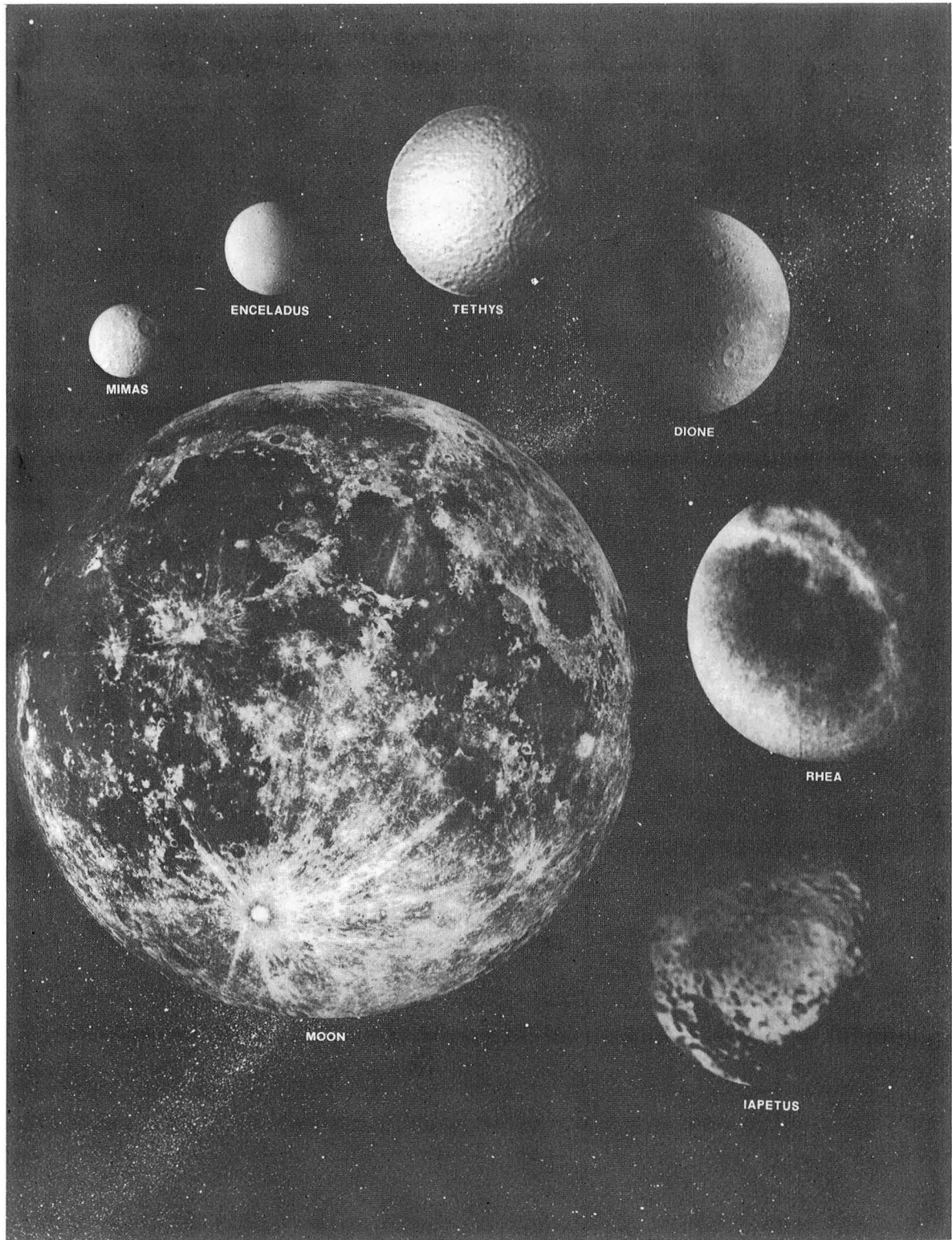
MOONS OF SATURN

The six medium-sized moons of Saturn are shown at the same scale as Earth's moon in this photo montage. While our moon is made of rock, these satellites of the "ringed planet" are composed predominantly of ice.

(Photo of Earth's moon courtesy of Lick Observatory).

Diameters

Earth's moon:	3,476 kilometers (2,160 miles)
Mimas:	392 kilometers (244 miles)
Enceladus:	500 kilometers (311 miles)
Tethys:	1,060 kilometers (659 miles)
Dione:	1,120 kilometers (696 miles)
Rhea:	1,530 kilometers (951 miles)
Iapetus:	1,460 kilometers (907 miles)

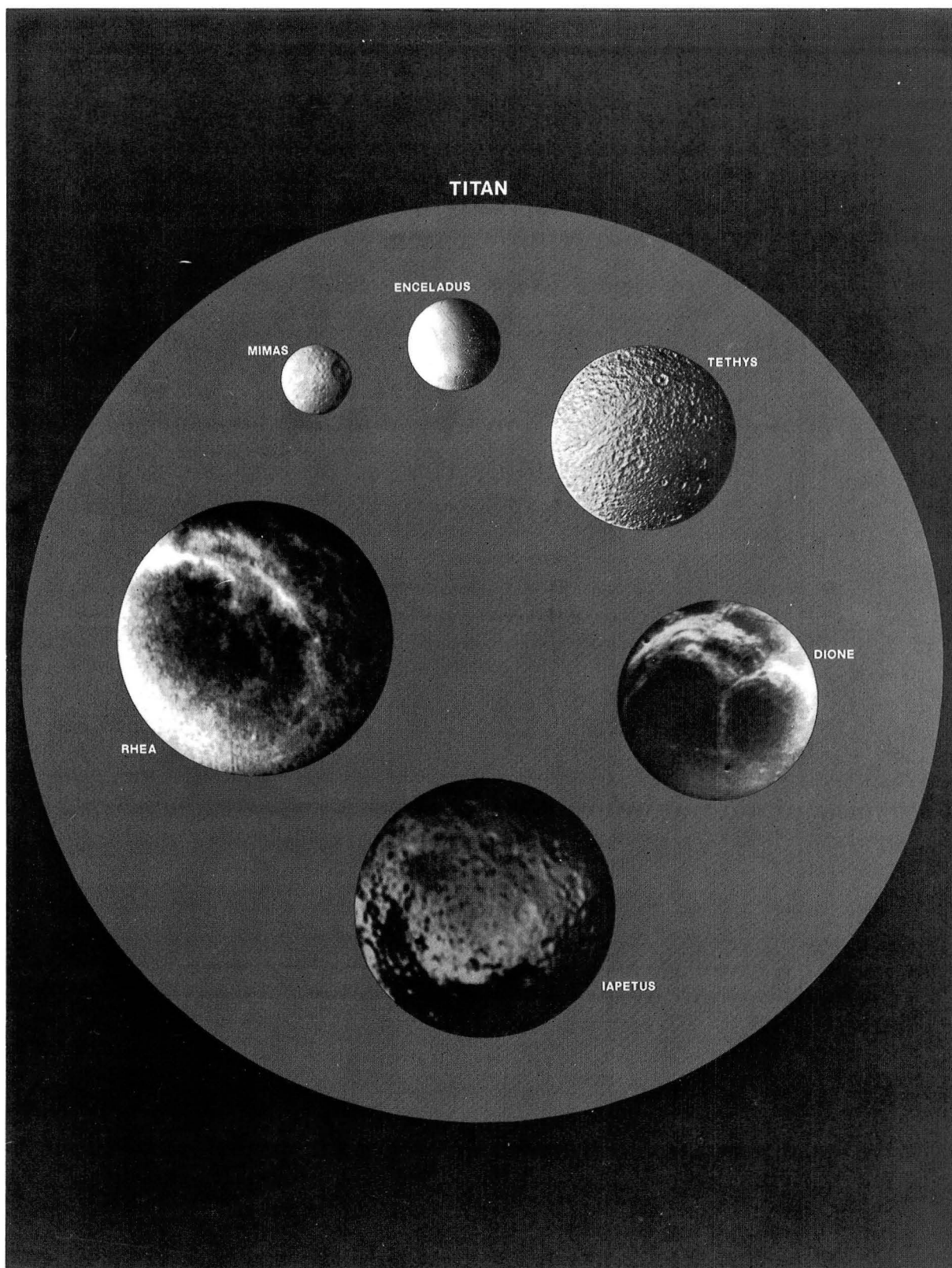


THE MOONS OF SATURN

Saturn's large moon Titan and its medium sized moons are shown at the same scale in this composite. Titan is pictured as it would appear in size if its thick atmosphere were eliminated. With a diameter of 5,150 kilometers (3,200 miles) it is one of the largest moons in the solar system.

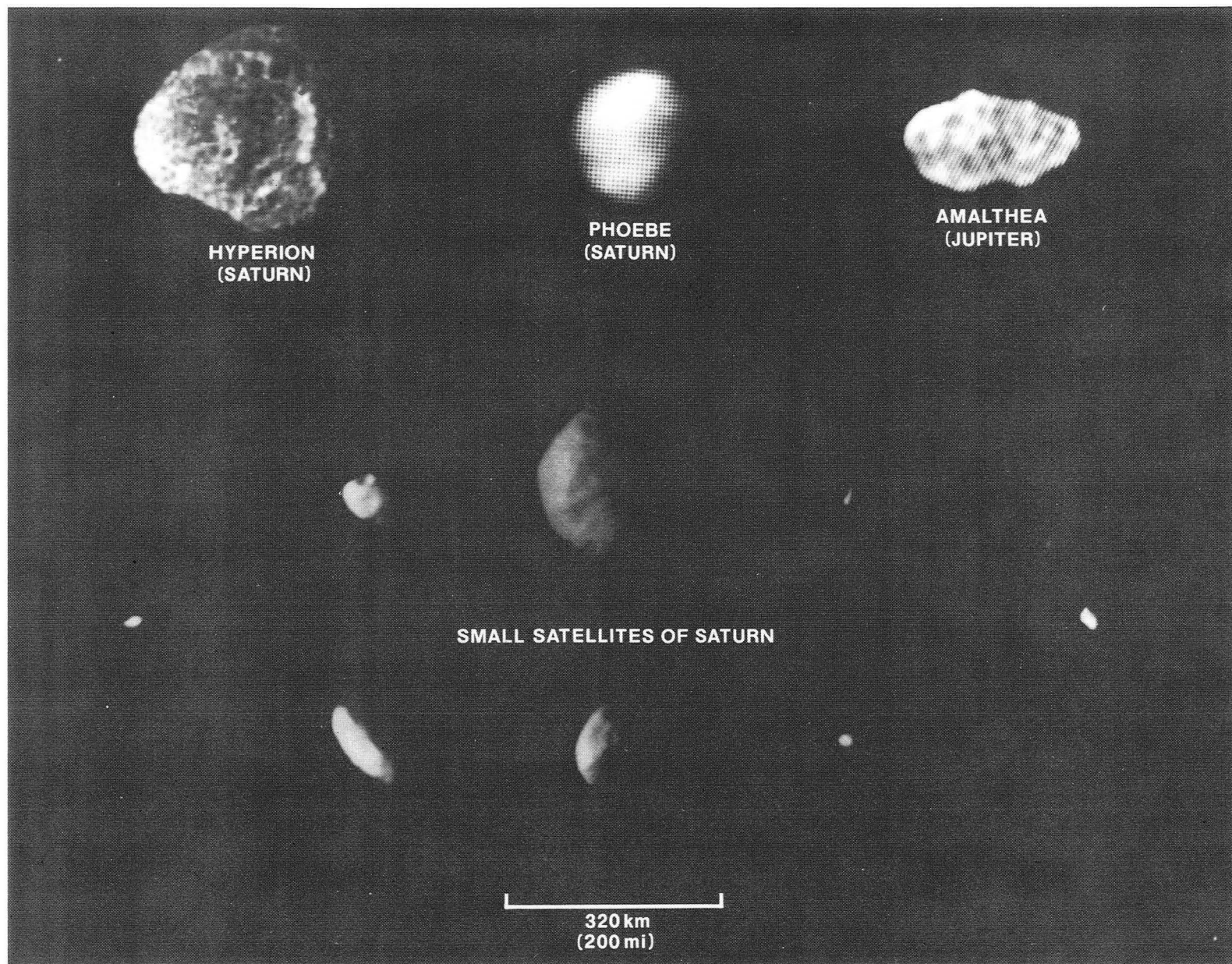
Diameters

Mimas:	392 kilometers	(244 miles)
Enceladus:	500 kilometers	(311 miles)
Tethys:	1,060 kilometers	(659 miles)
Dione:	1,120 kilometers	(696 miles)
Iapetus:	1,460 kilometers	(907 miles)
Rhea:	1,530 kilometers	(951 miles)
Titan:	5,150 kilometers	(3,200 miles)



SMALL MOONS

Some of the smaller moons of Jupiter and Saturn are pictured here at the same scale. They are generally irregular in shape since their gravities are too weak to pull them into spheres.



THE MOONS OF MARS

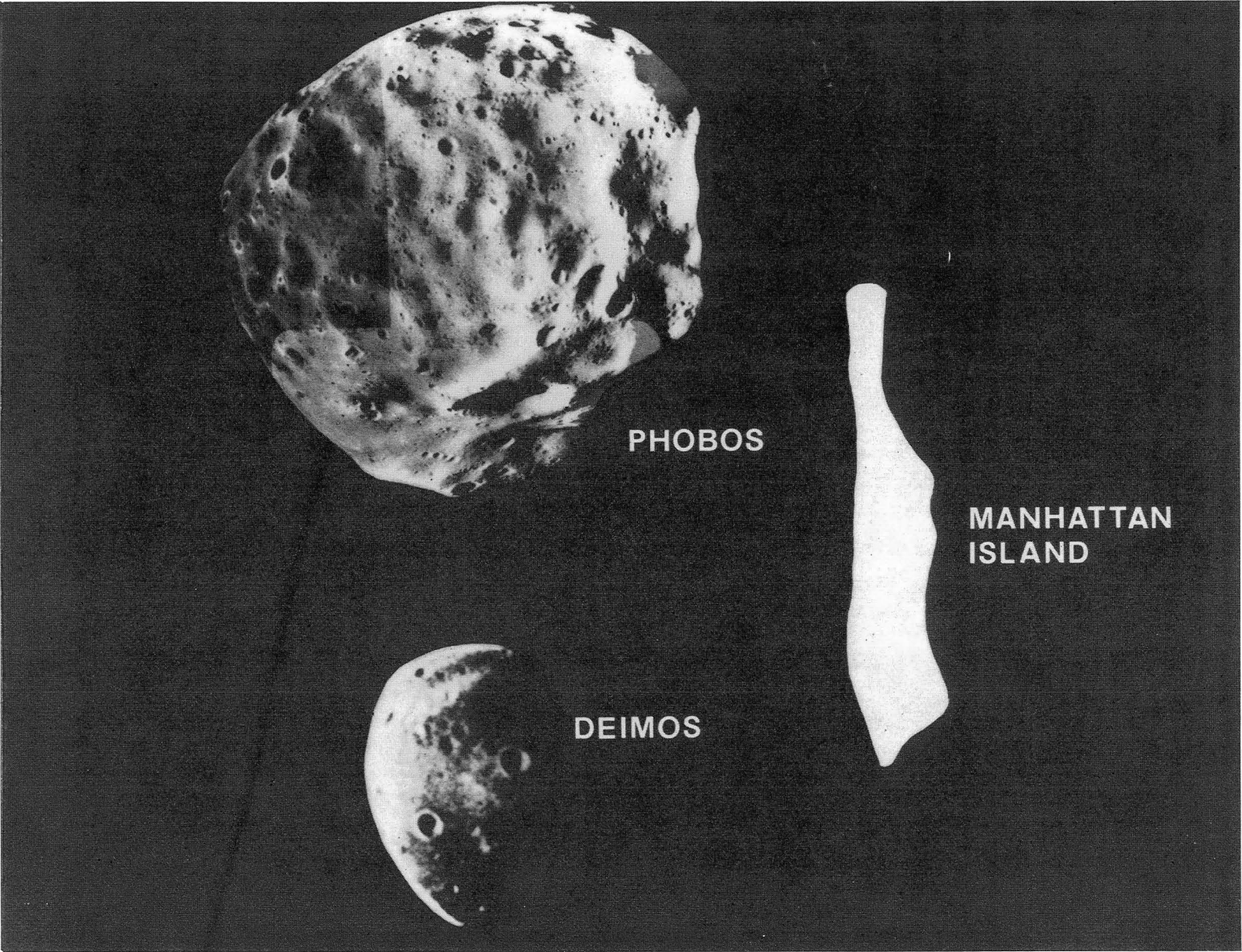
Phobos and Deimos, the two small moons of Mars, are compared in size with Manhattan Island, New York City.

Approximate Diameters

(very irregular sizes)

Phobos: 22 kilometers (14 miles)

Deimos: 12 kilometers (7 miles)



PHOBOS

MANHATTAN
ISLAND

DEIMOS

PART II: INDIVIDUAL COMPARISONS

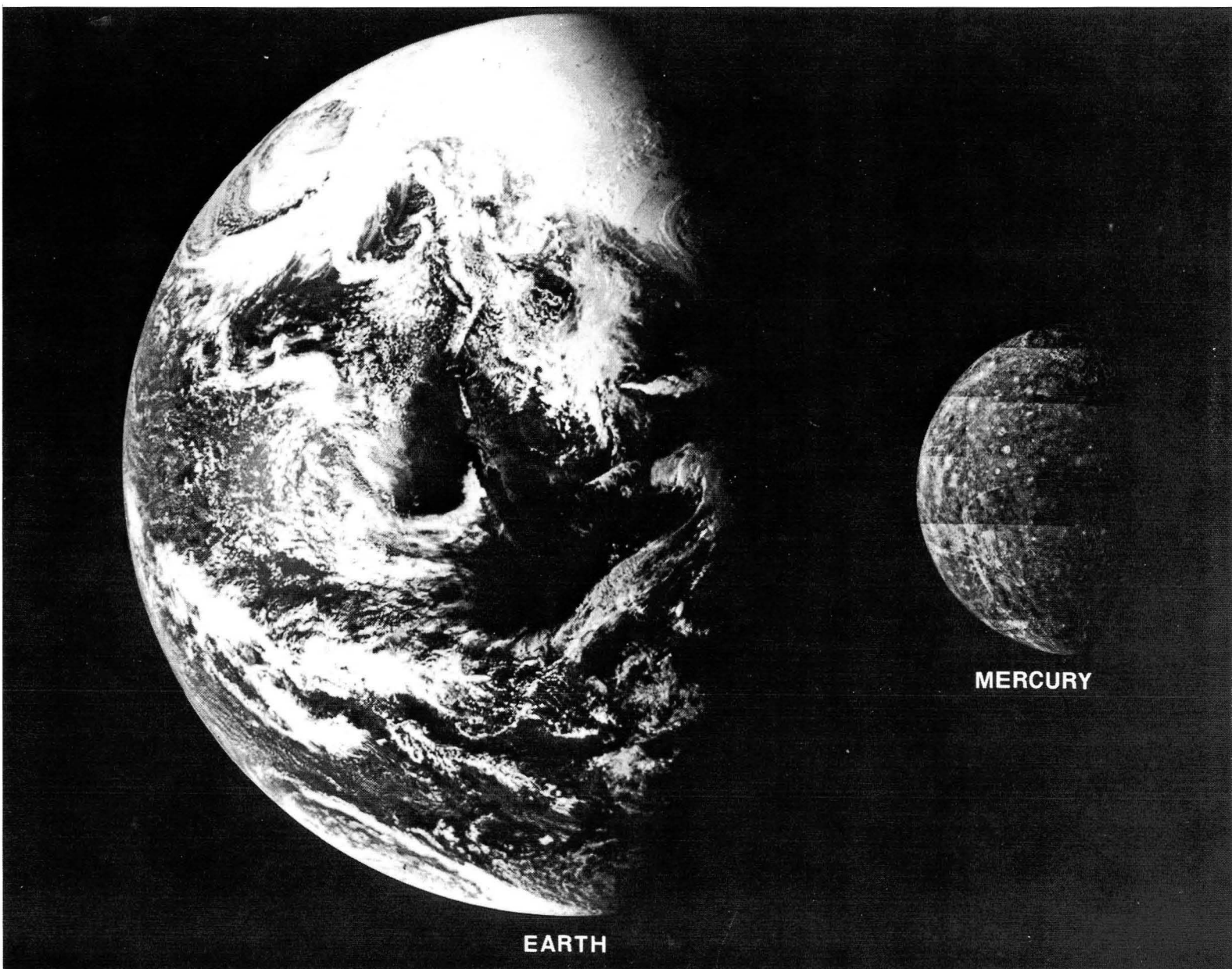
MERCURY AND EARTH

Mercury and the Earth at the same scale.

Diameters

Mercury: 4,878 kilometers (3,031 miles)

Earth: 12,756 kilometers (7,927 miles)



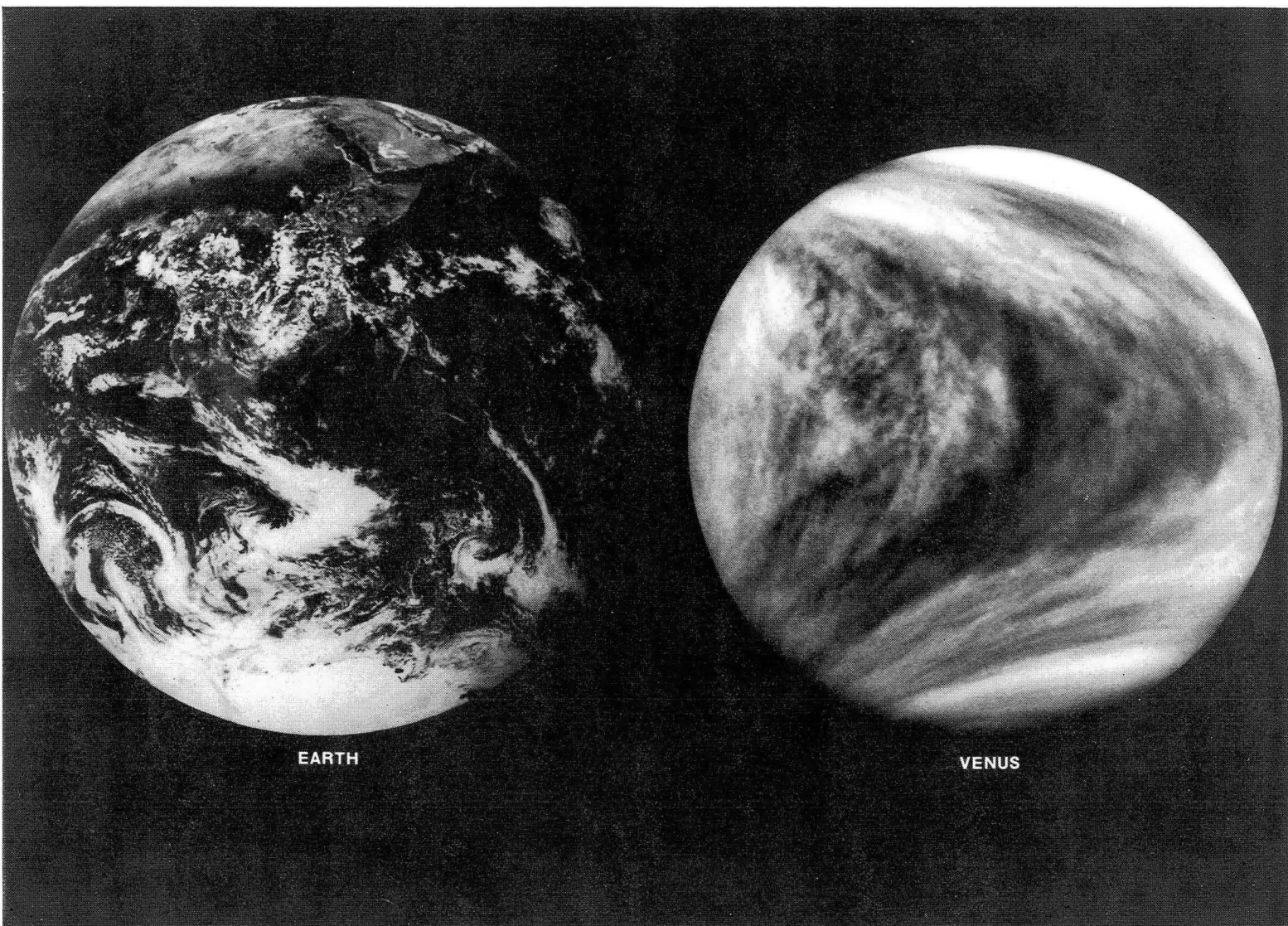
VENUS AND EARTH

Venus and the Earth at the same scale.

Diameters

Venus: 12,104 kilometers (7,521 miles)

Earth: 12,756 kilometers (7,927 miles)



EARTH

VENUS

EARTH AND MOON

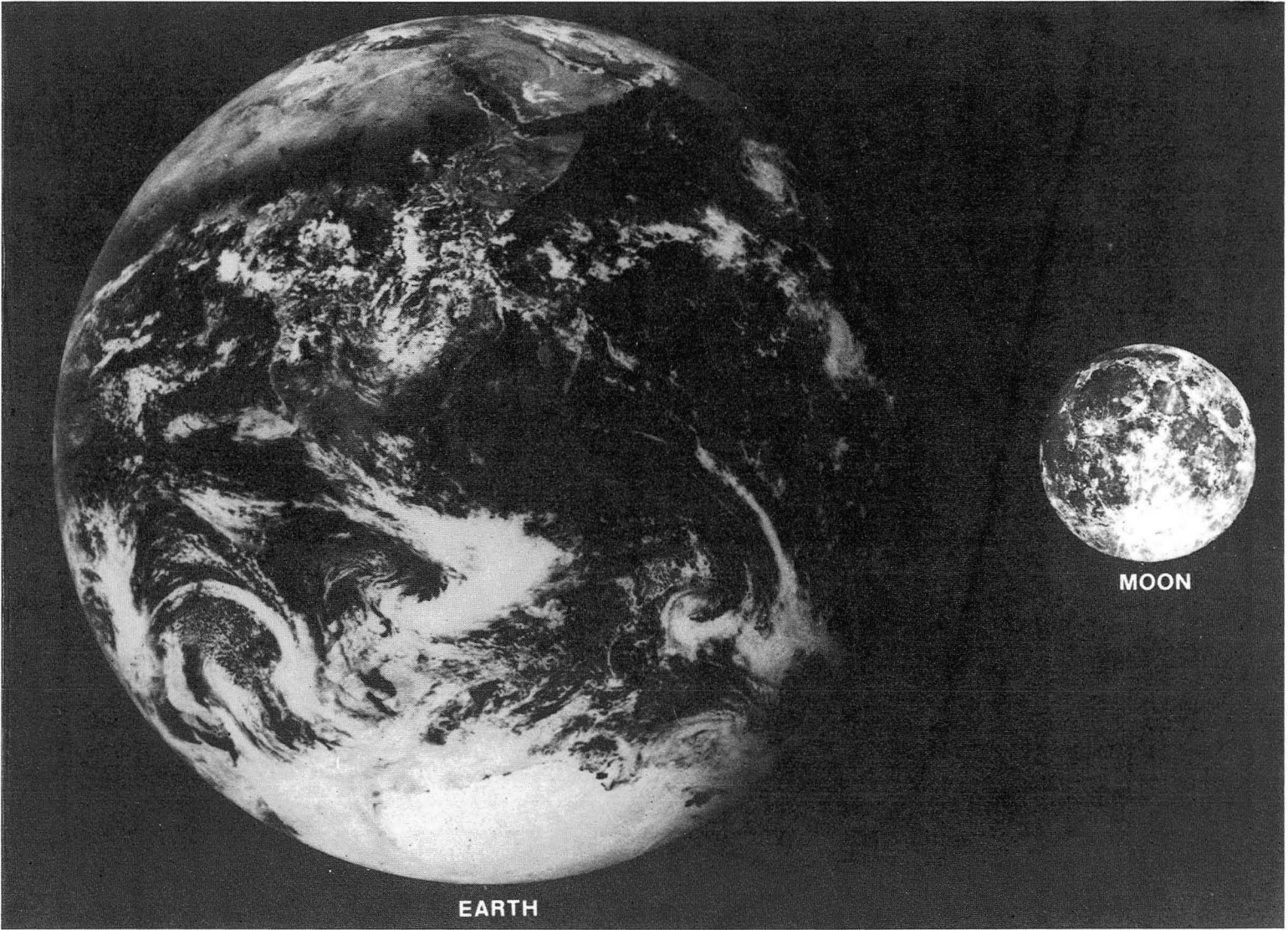
The Earth and the moon at the same scale.

(Moon photo courtesy of Lick Observatory).

Diameters

Earth: 12,756 kilometers (7,927 miles)

Moon: 3,476 kilometers (2,160 miles)



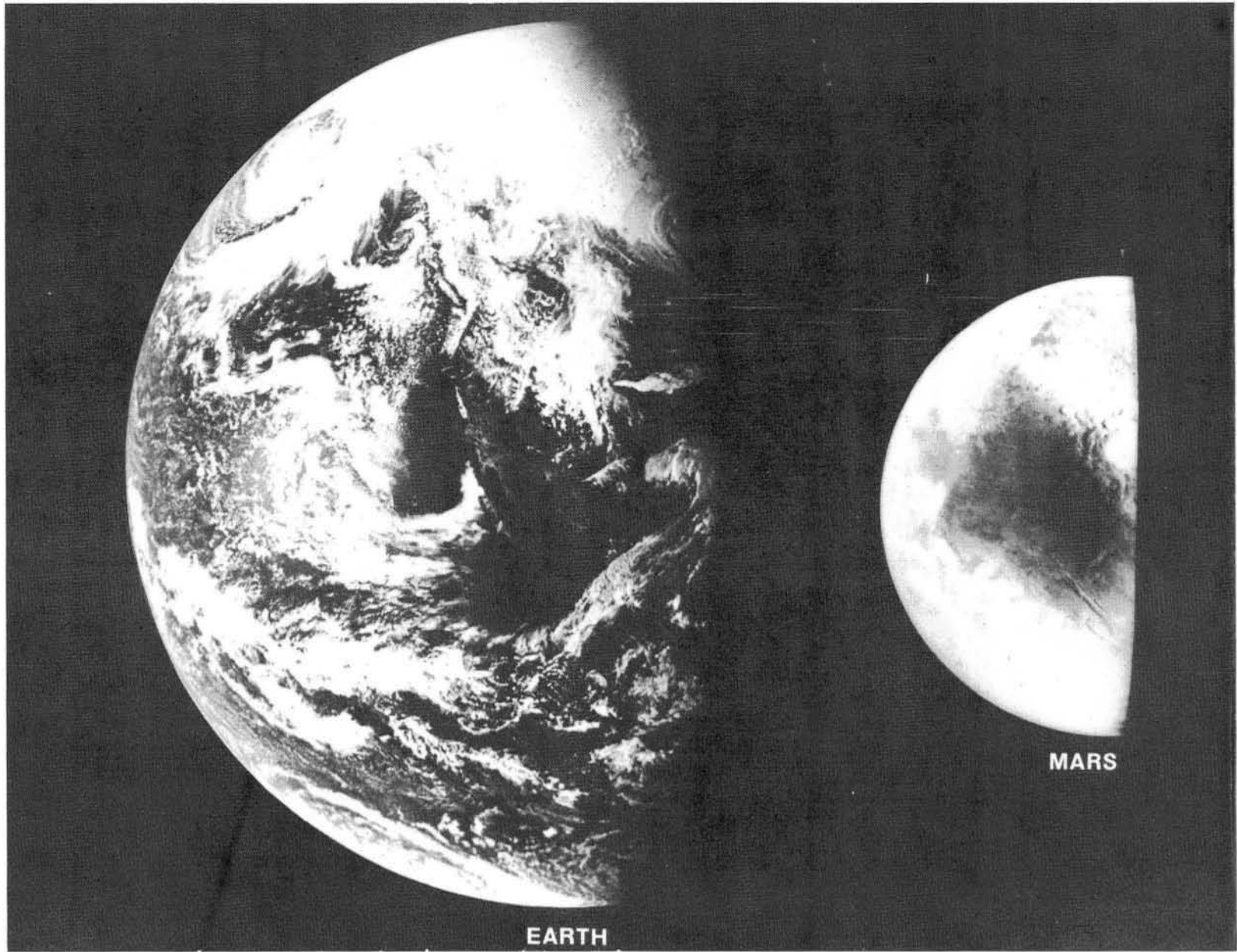
MARS AND EARTH

Mars and the Earth at the same scale.

Diameters

Mars: 6,796 kilometers (4,223 miles)

Earth: 12,756 kilometers (7,927 miles)



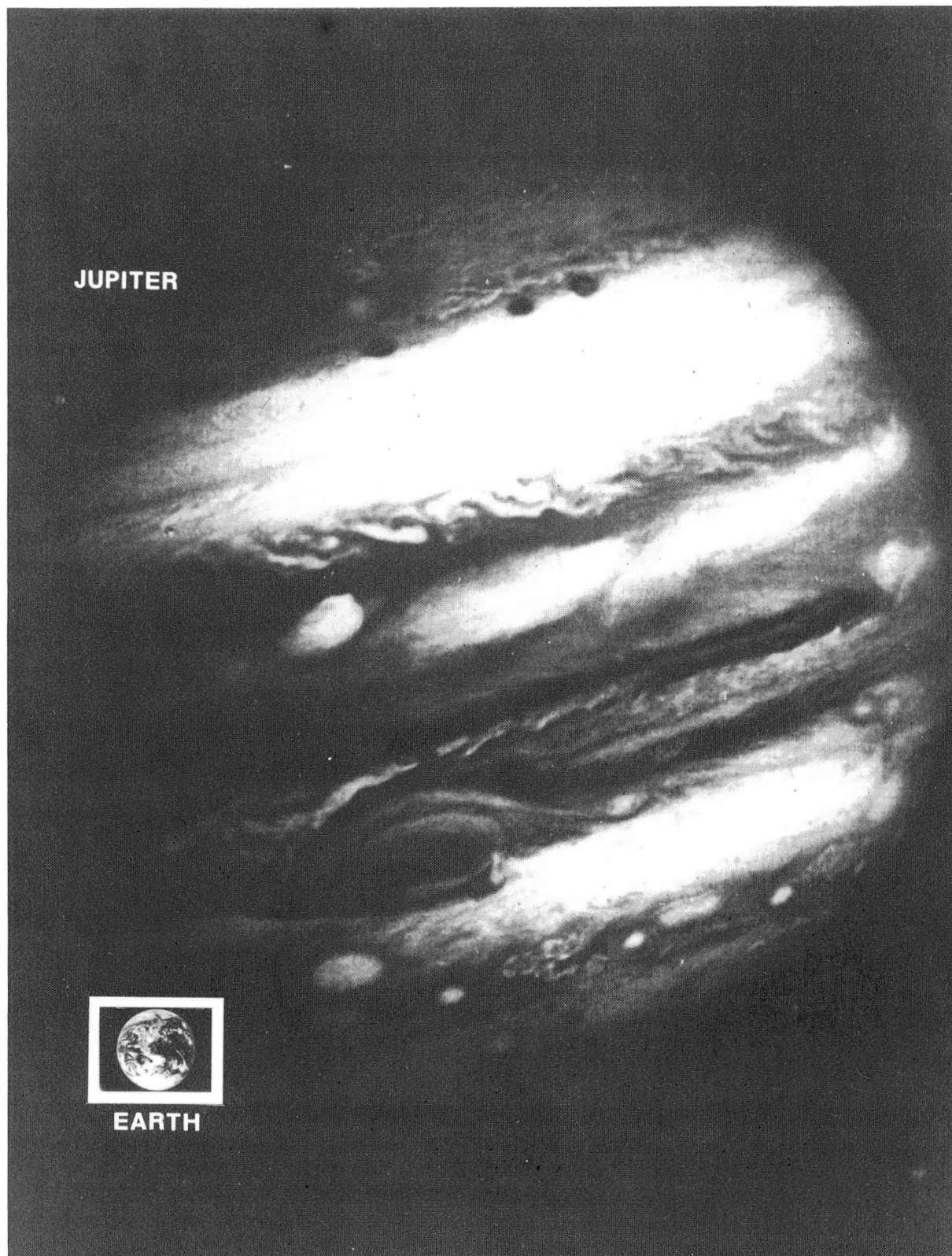
JUPITER AND EARTH

Jupiter and the Earth at the same scale.

Diameters

Jupiter: 142,796 kilometers (88,733 miles)

Earth: 12,756 kilometers (7,927 miles)



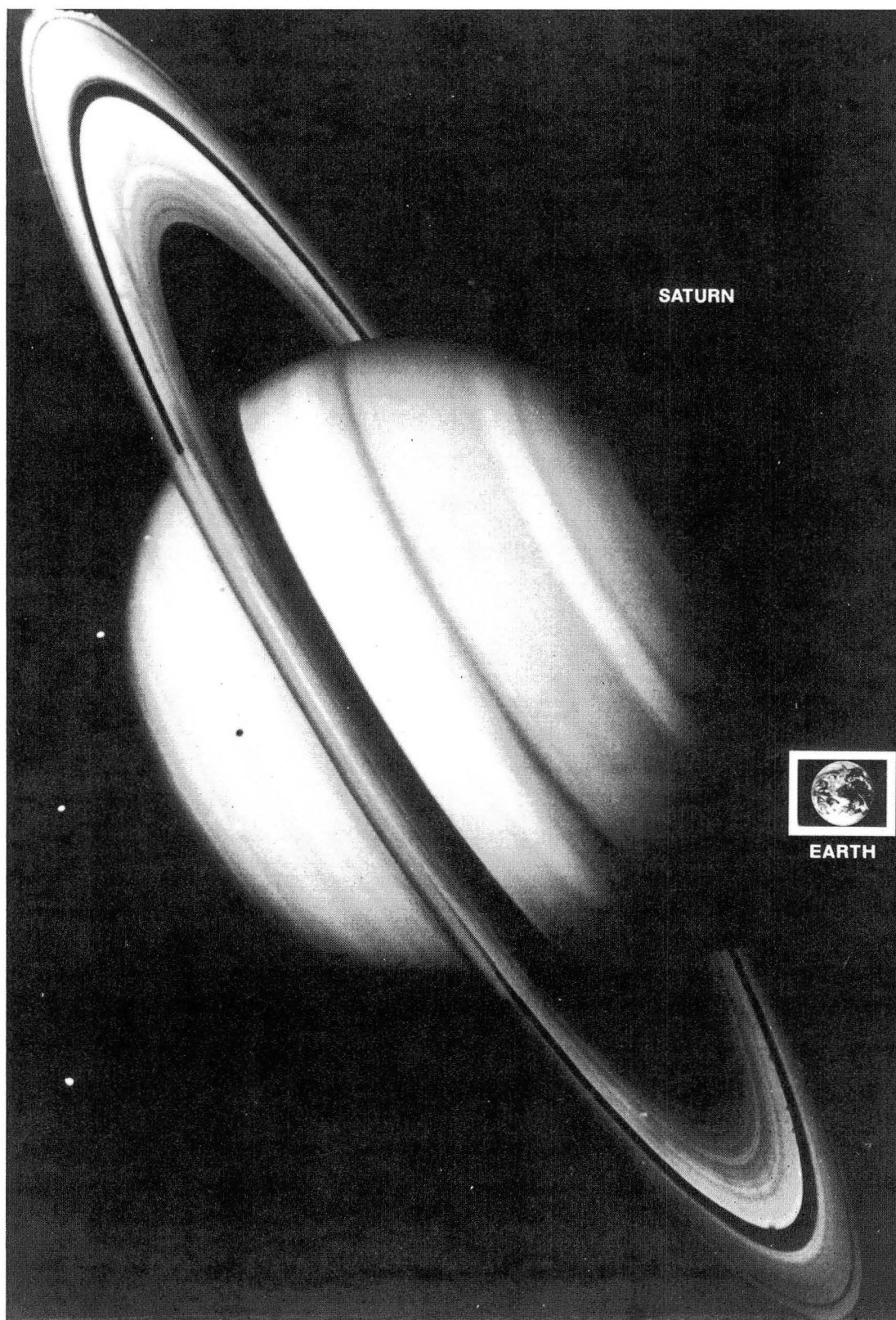
SATURN AND EARTH

Saturn and the Earth at the same scale.

Diameters

Saturn: 120,660 kilometers (74,978 miles)

Earth: 12,756 kilometers (7,927 miles)



URANUS AND EARTH

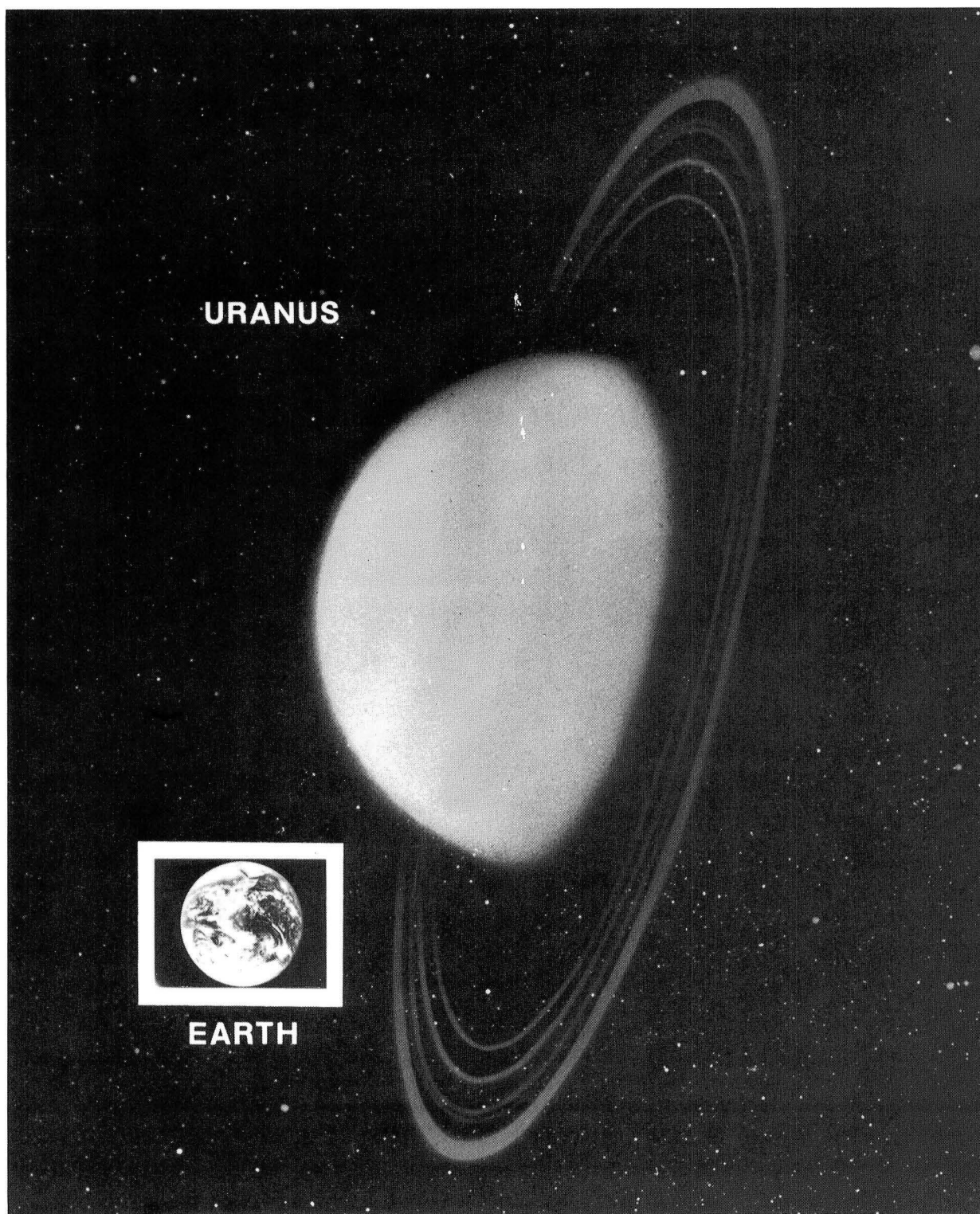
Uranus and the Earth at the same scale.

(Uranus is an artist's rendering).

Diameters

Uranus: 50,800 kilometers (31,567 miles)

Earth: 12,756 kilometers (7,927 miles)



NEPTUNE AND EARTH

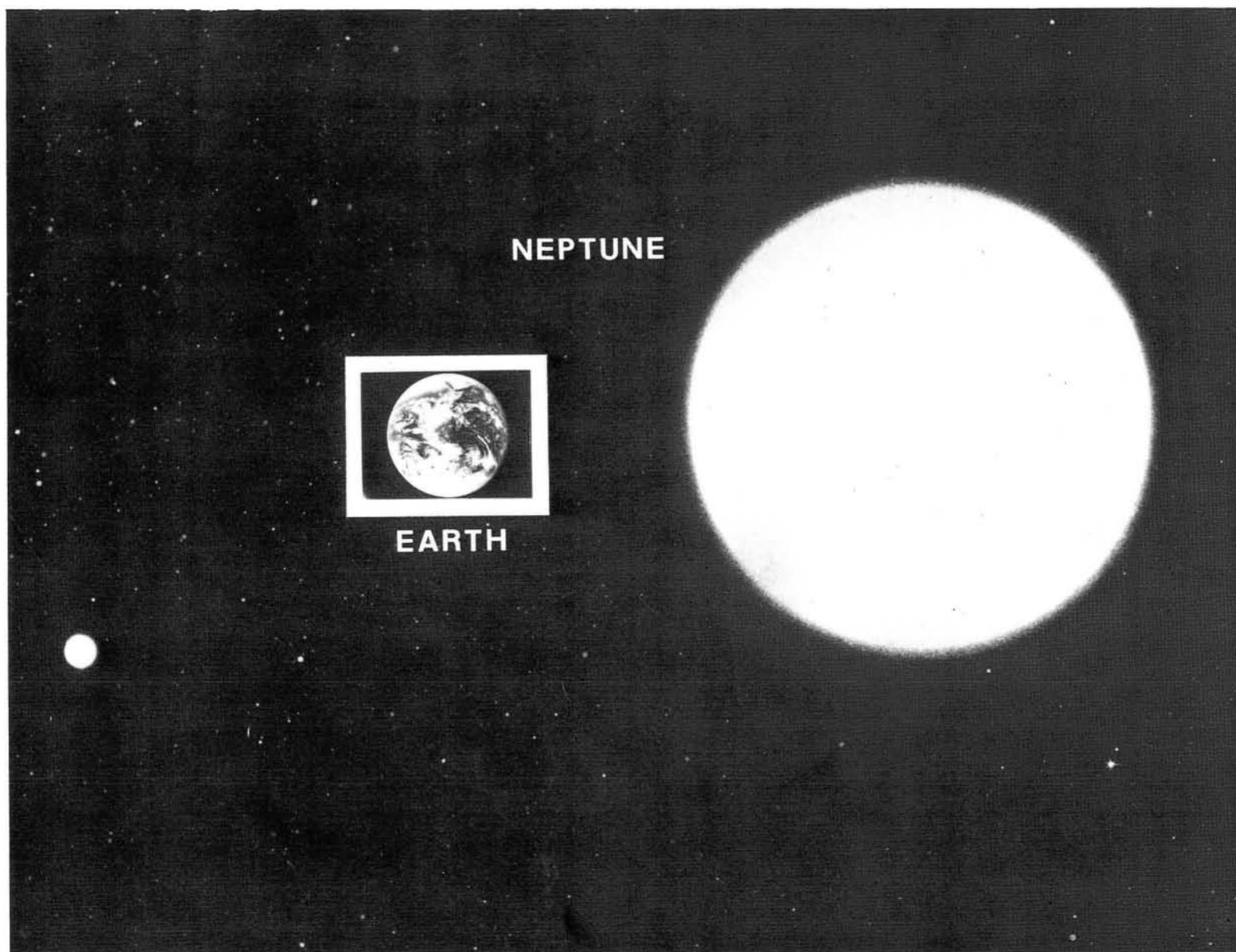
Neptune and the Earth at the same scale.

(Neptune is an artist's rendering).

Diameters

Neptune: 48,600 kilometers (30,200 miles)

Earth: 12,756 kilometers (7,927 miles)



PLUTO SIZE RANGE

The moon is compared with the possible size range of the planet Pluto. Since Pluto is so distant and no spacecraft has yet visited it, its exact size is imperfectly known.

(Photo of Earth's moon courtesy of Lick Observatory).

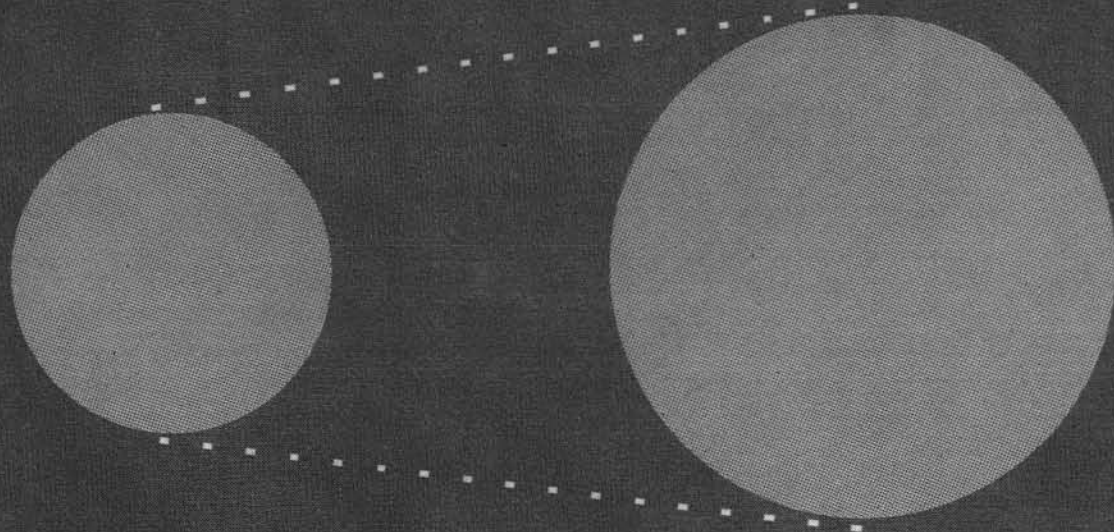
Diameters

Pluto range: 2,400 - 3,800 kilometers
 (1,490 - 2,360 miles)

Moon: 3,476 kilometers (2,160 miles)



MOON



PLUTO: POSSIBLE SIZE RANGE

IO AND THE MOON

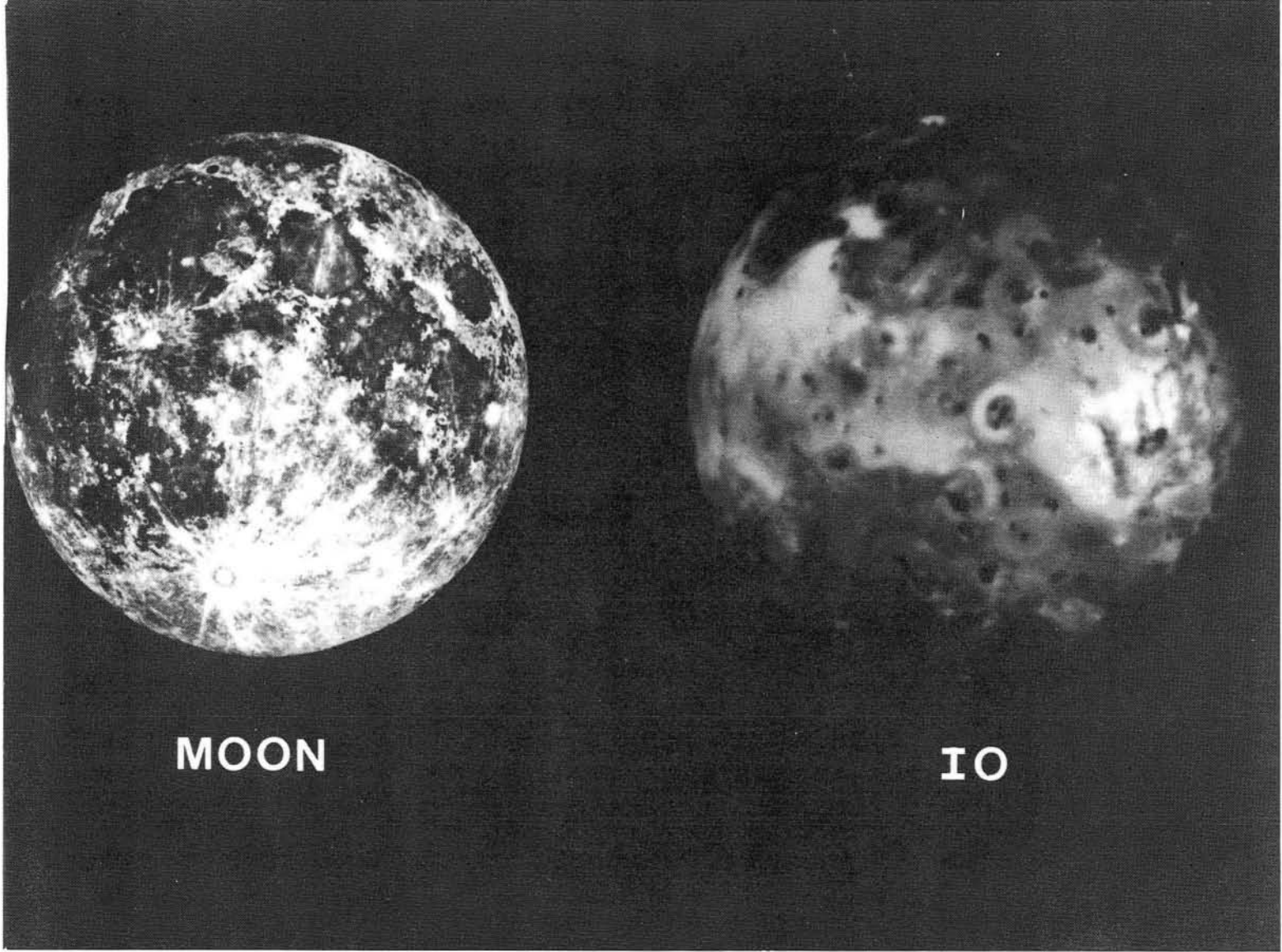
Jupiter's moon Io and the Earth's moon at the same scale.

(Photo of Earth's moon courtesy of Lick Observatory).

Diameters

Io: 3,632 kilometers (2,257 miles)

Moon: 3,476 kilometers (2,160 miles)



MOON

IO

EUROPA AND THE MOON

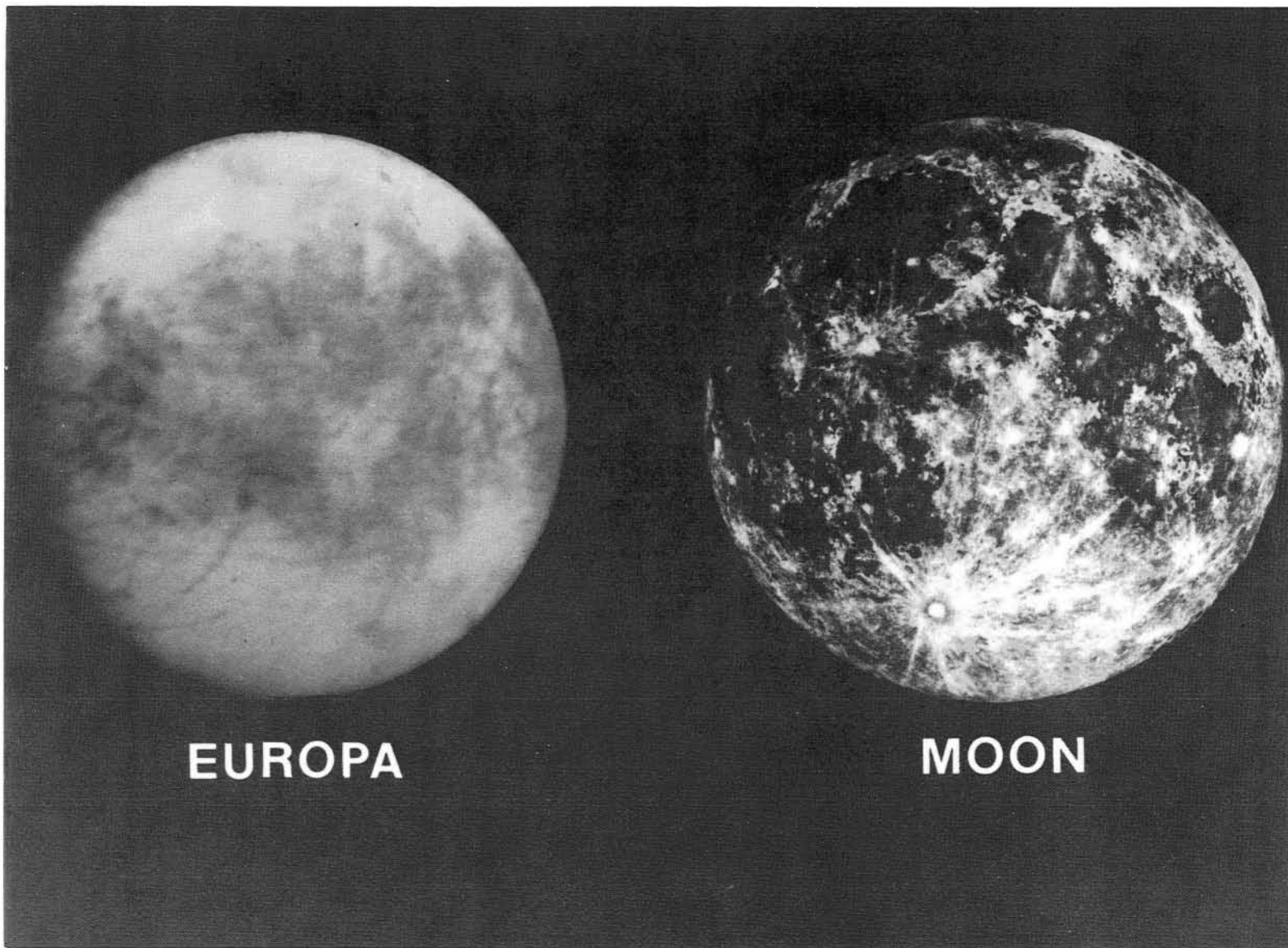
Jupiter's moon Europa and the Earth's moon at the same scale.

(Photo of Earth's moon courtesy of Lick Observatory).

Diameters

Europa: 3,126 kilometers (1,942 miles)

Moon: 3,476 kilometers (2,160 miles)



GANYMEDE AND THE MOON

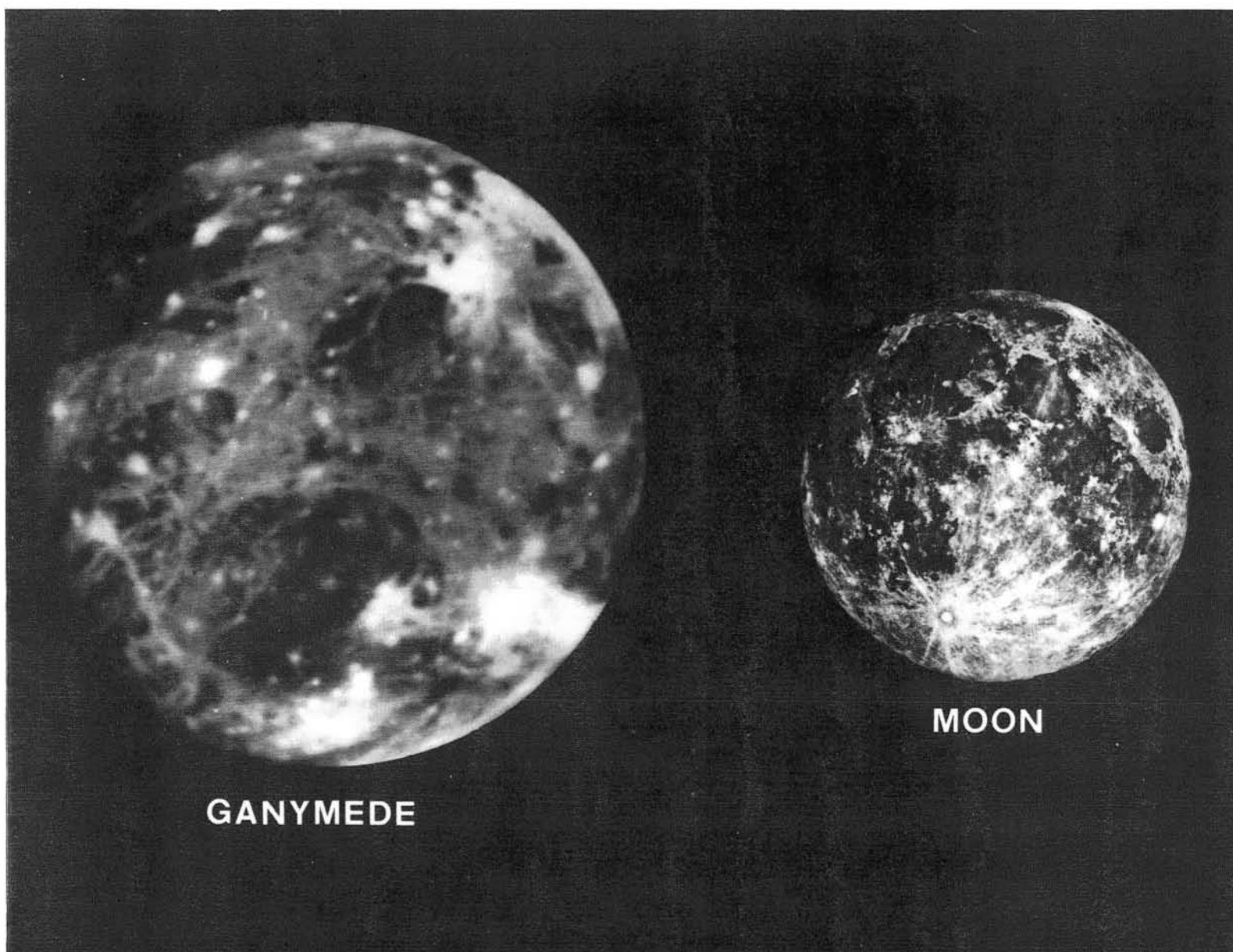
Jupiter's moon Ganymede and the Earth's moon at the same scale.

(Photo of Earth's moon courtesy of Lick Observatory).

Diameters

Ganymede: 5,276 kilometers (3,279 miles)

Moon: 3,476 kilometers (2,160 miles)



GANYMEDE

MOON

CALLISTO AND THE MOON

Jupiter's moon Callisto and the Earth's moon at the same scale.

(Photo of Earth's moon courtesy of Lick Observatory).

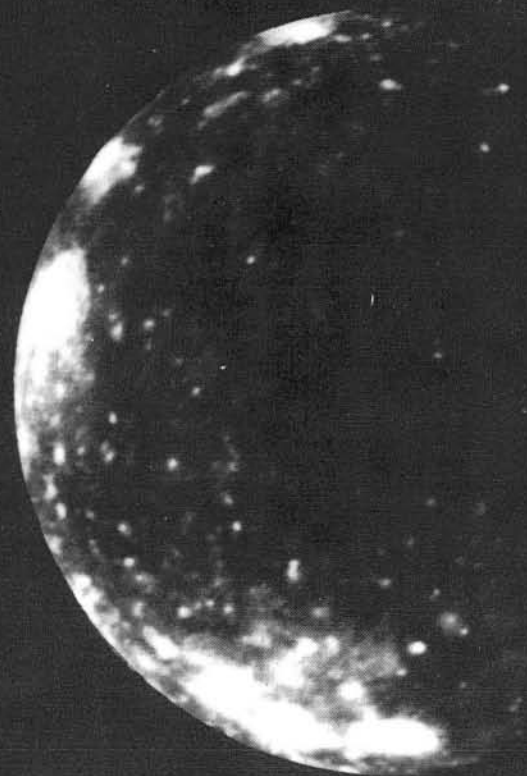
Diameters

Callisto: 4,820 kilometers (2,995 miles)

Moon: 3,476 kilometers (2,160 miles)



MOON



CALLISTO

TITAN AND THE MOON

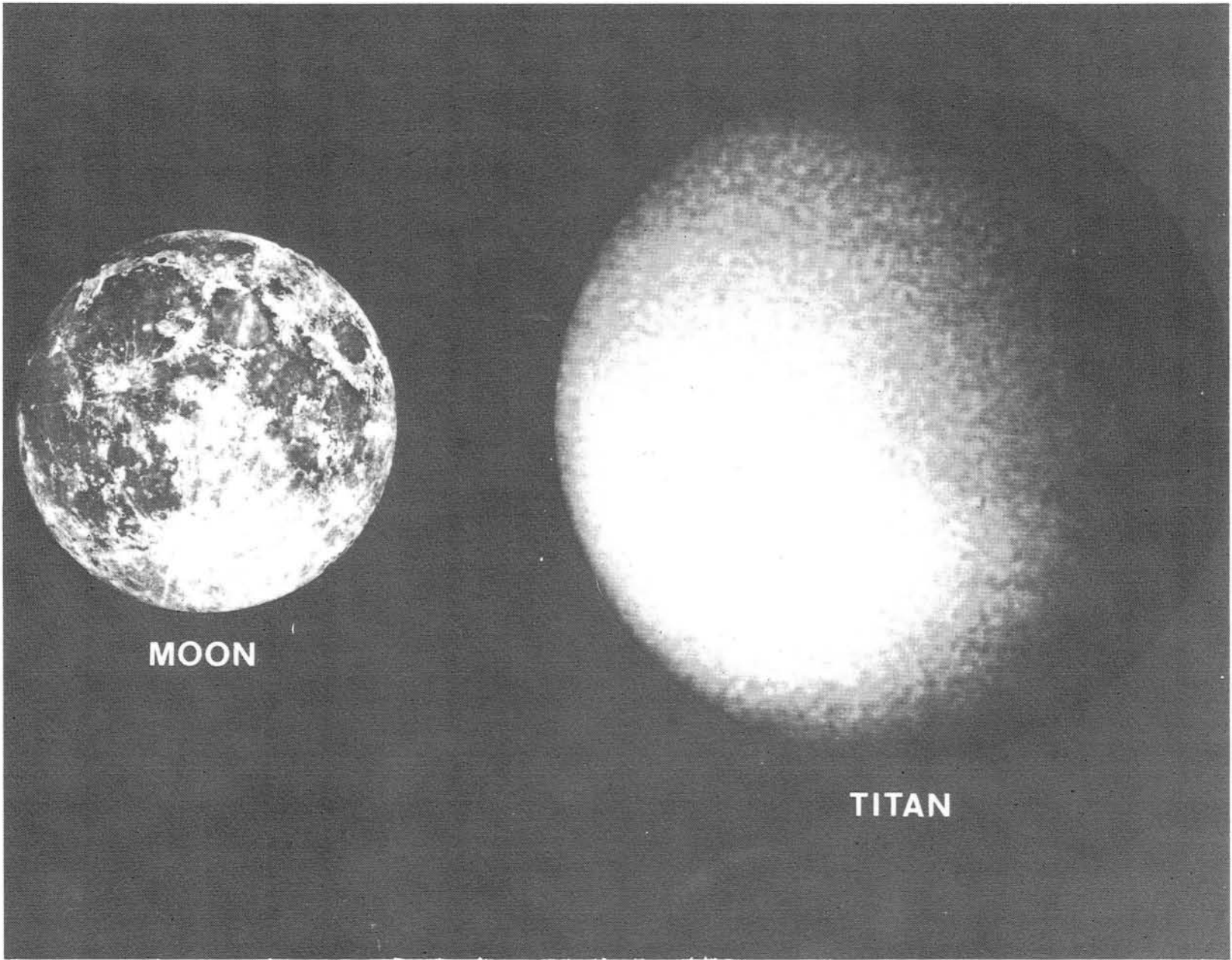
Saturn's moon Titan and the Earth's moon at the same scale.

(Photo of Earth's moon courtesy of Lick Observatory).

Diameters

Titan: 5,150 kilometers (3,200 miles)

Moon: 3,476 kilometers (2,160 miles)



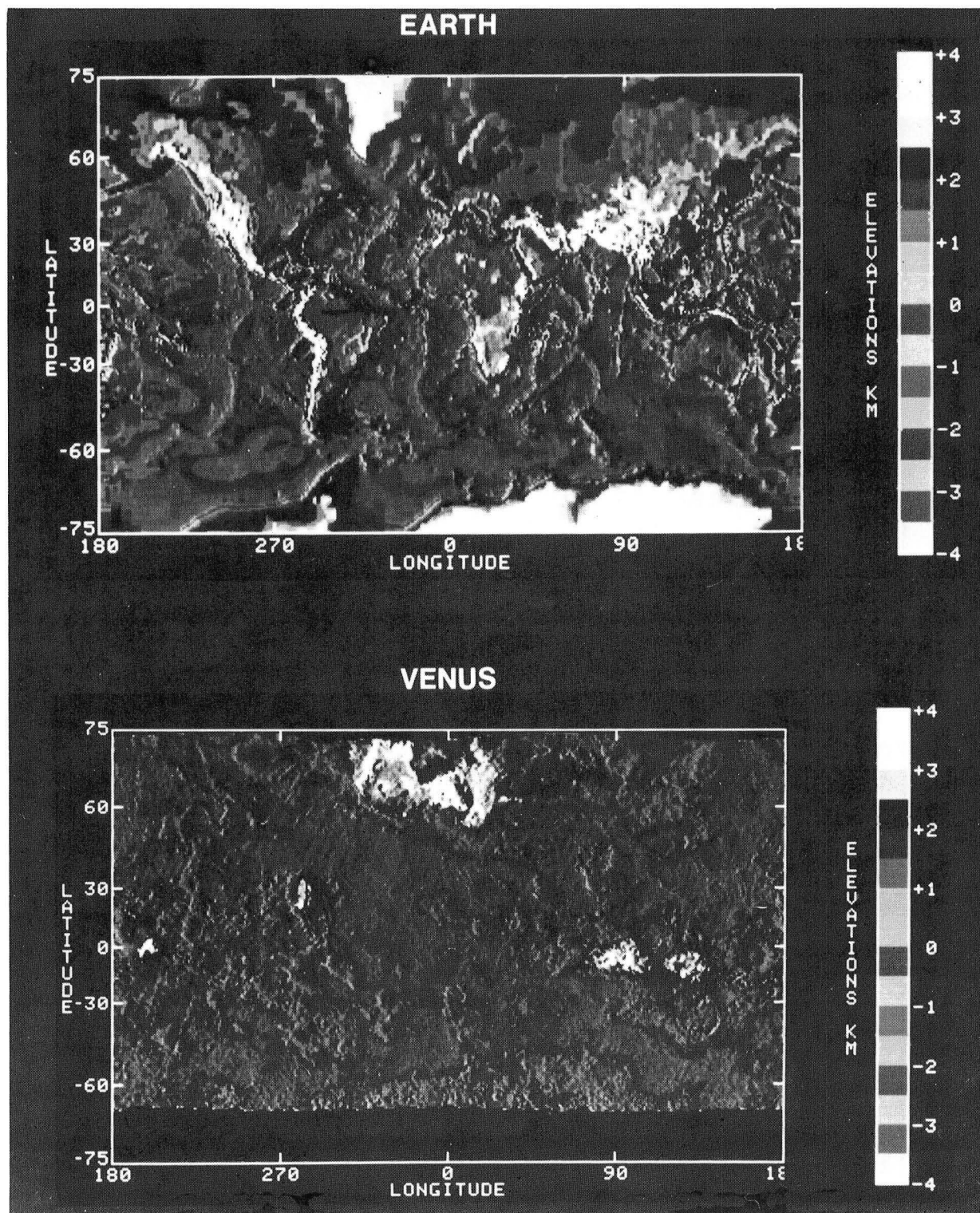
MOON

TITAN

PART III: SPECIAL COMPARISONS

RADAR VIEWS: EARTH AND VENUS

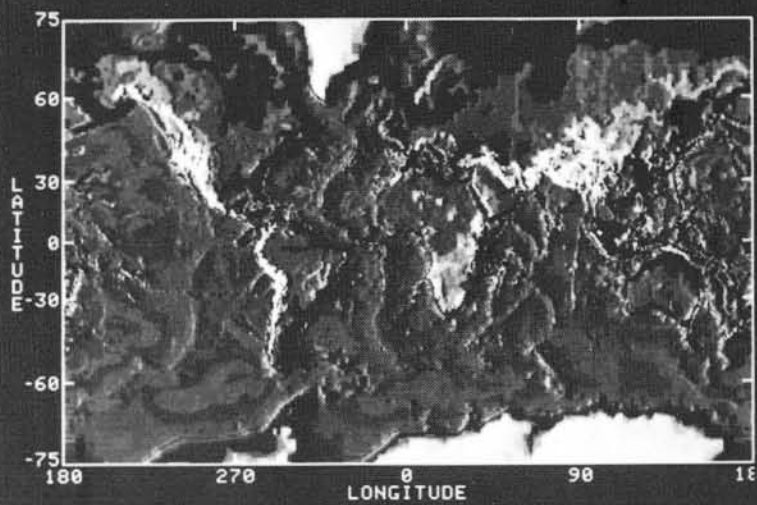
Maps of the Earth and Venus are shown at the same scale. The surface topography of both planets is displayed at the same radar resolution as that achieved by the Pioneer-Venus spacecraft.



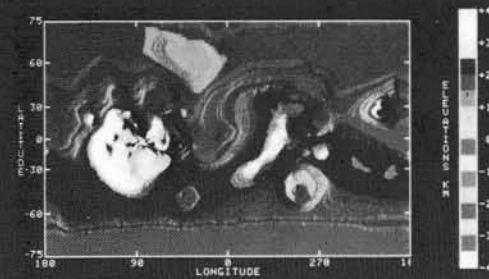
RADAR VIEWS: EARTH, VENUS, MARS

Maps of the Earth, Venus, and Mars are shown at the same scale. The surface topography of all three planets is displayed at the same radar resolution as that achieved by the Pioneer-Venus spacecraft.

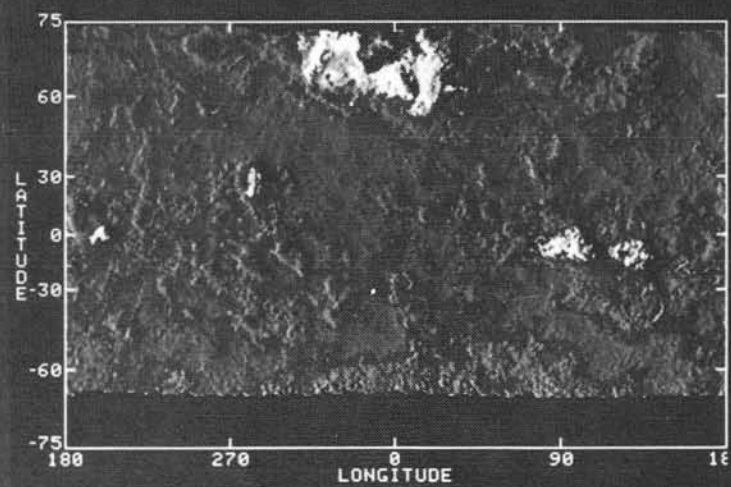
EARTH



MARS

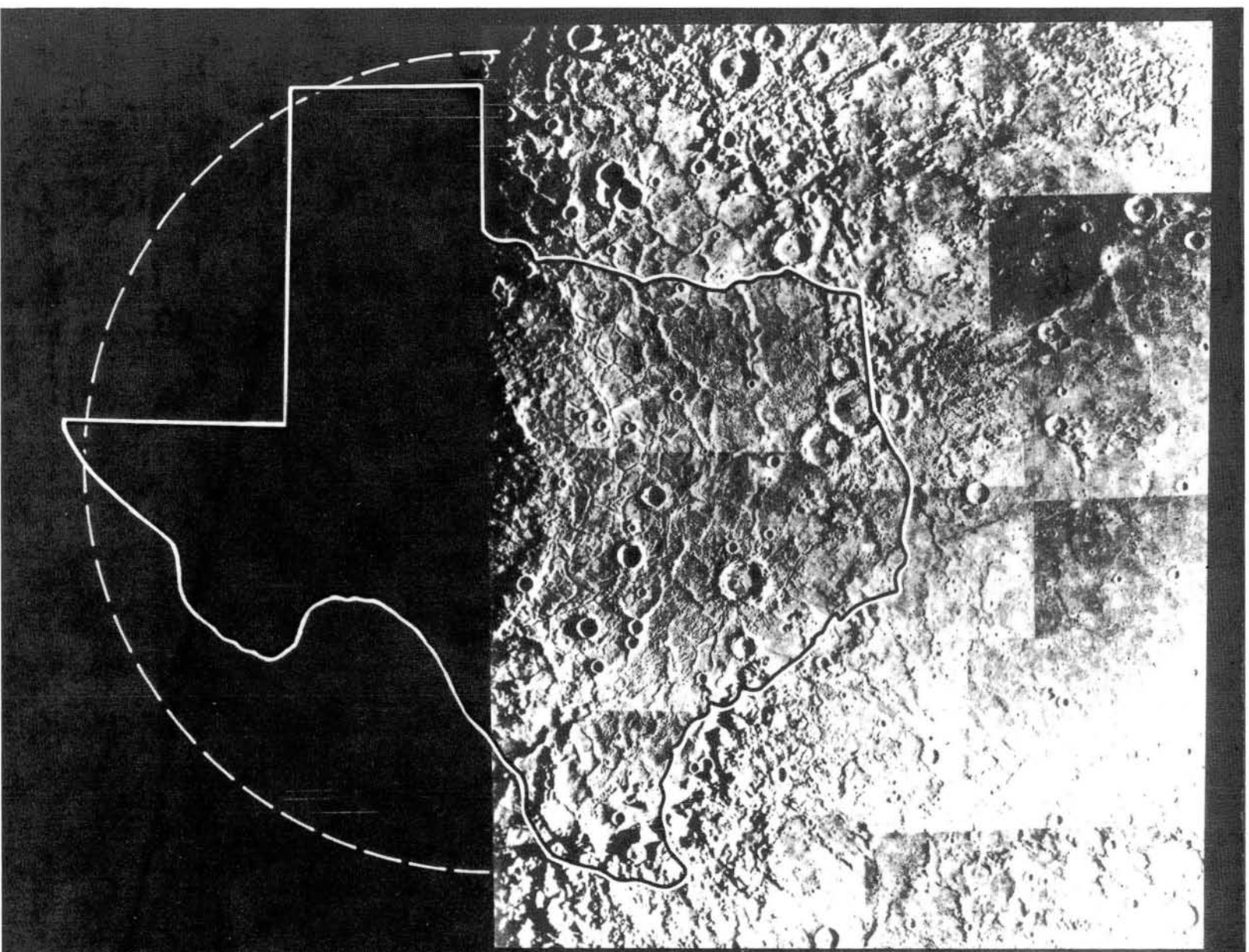


VENUS



THE CALORIS BASIN

The immense size of the Caloris Basin on Mercury is shown in this comparison. 1300 kilometers (800 miles) in diameter, it could easily hold the state of Texas. The basin was caused by the violent impact of a large asteroid several billion years ago.



ISHTAR TERRA

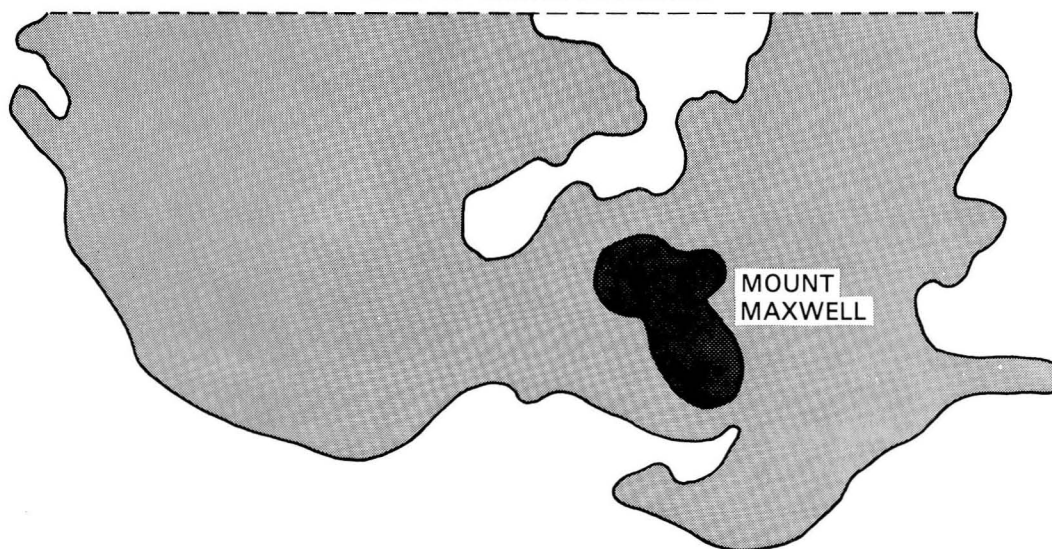
One of the large upland areas or “continents” on the planet Venus is shown at the same scale as the United States. Named Ishtar Terra, its outlines were delineated by radar from the Pioneer-Venus spacecraft. Mount Maxwell on Ishtar Terra rises to an elevation higher than Mount Everest on the Earth.

UNITED STATES



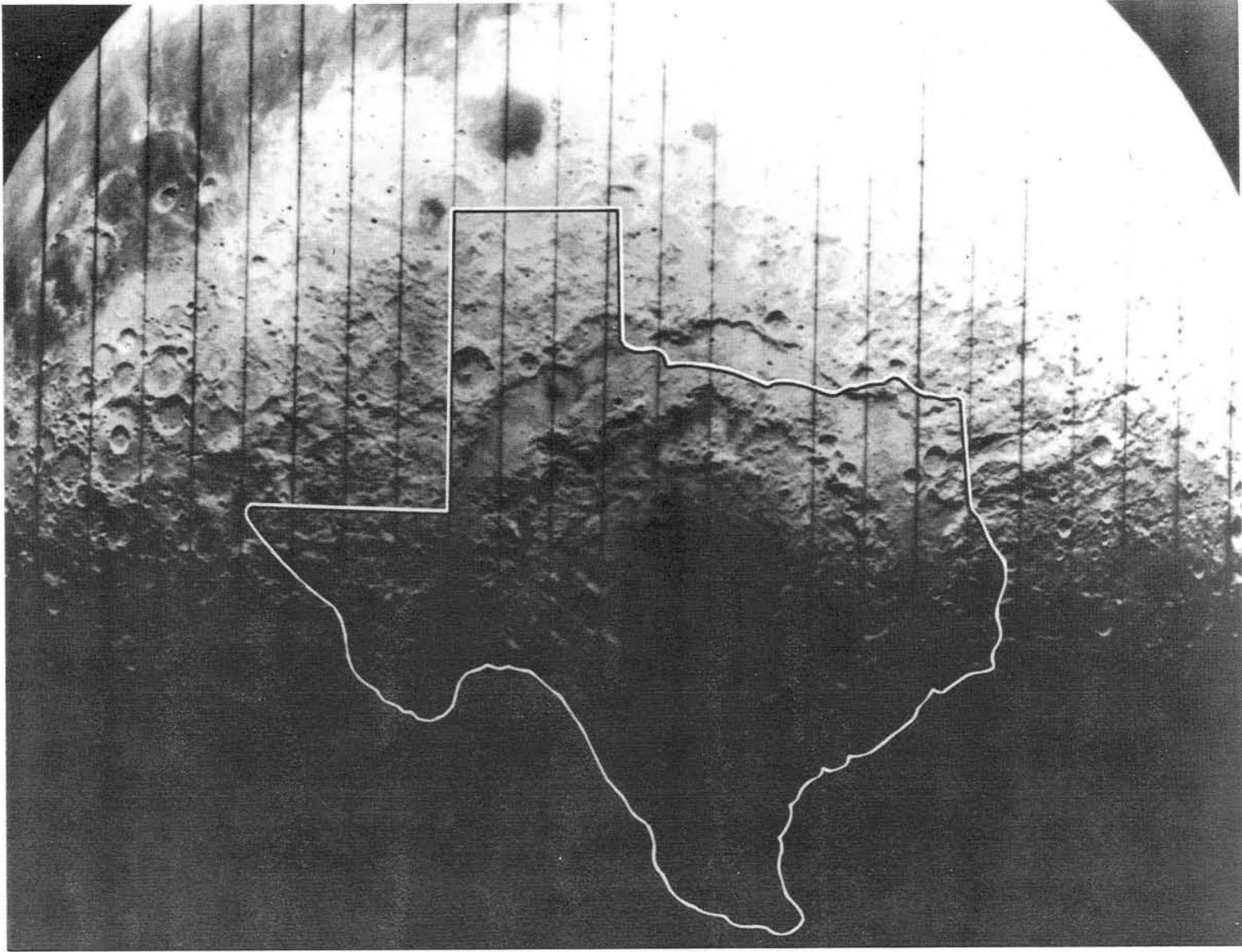
ISHTAR TERRA (VENUS)

LIMIT OF RADAR COVERAGE



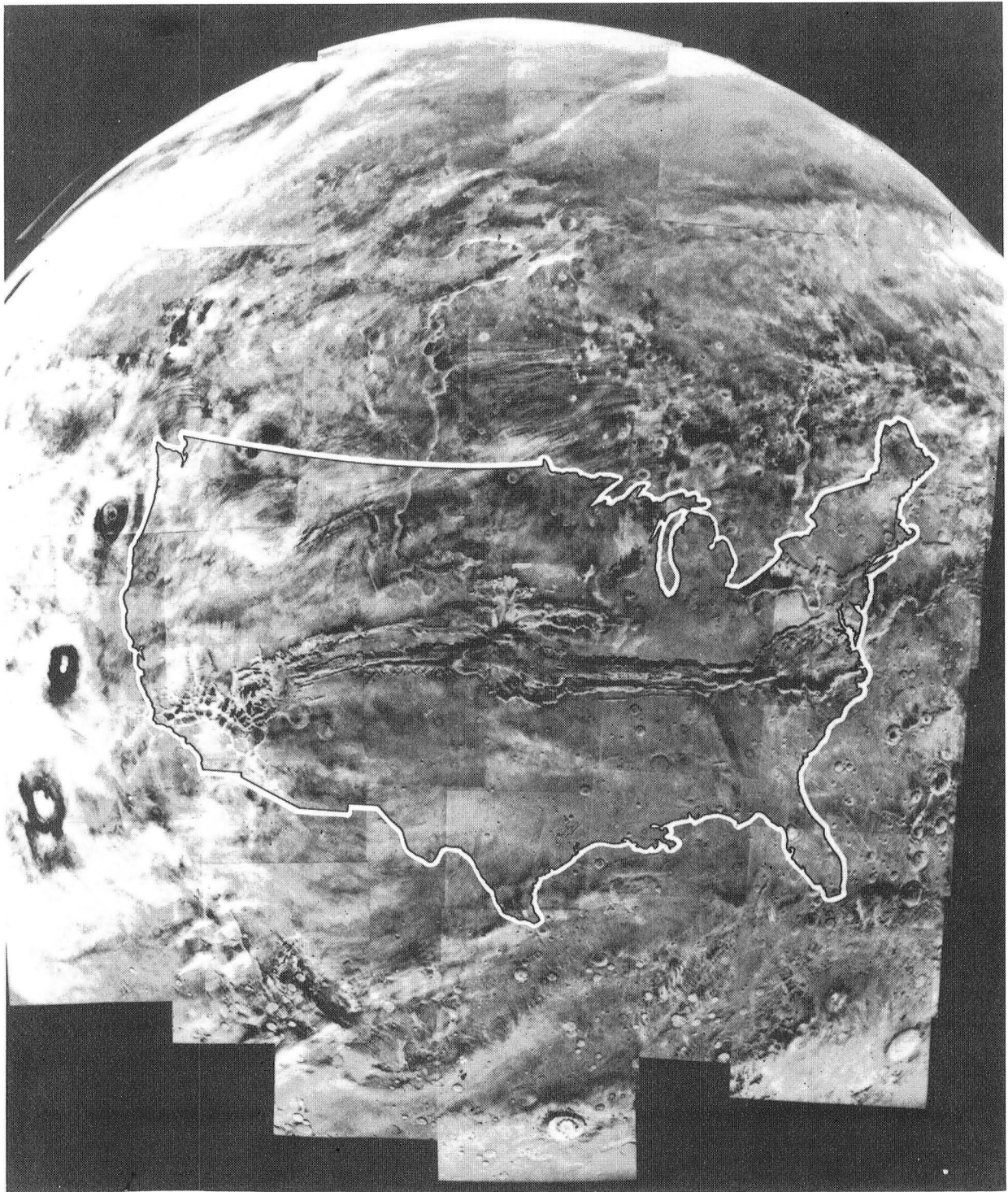
MARE ORIENTALE

The huge size of the Mare Orientale Basin on the moon is shown in this comparison. Almost 1000 kilometers (600 miles) across, it is as large as the state of Texas. The basin was originally caused by the impact of a large asteroid several billion years ago.



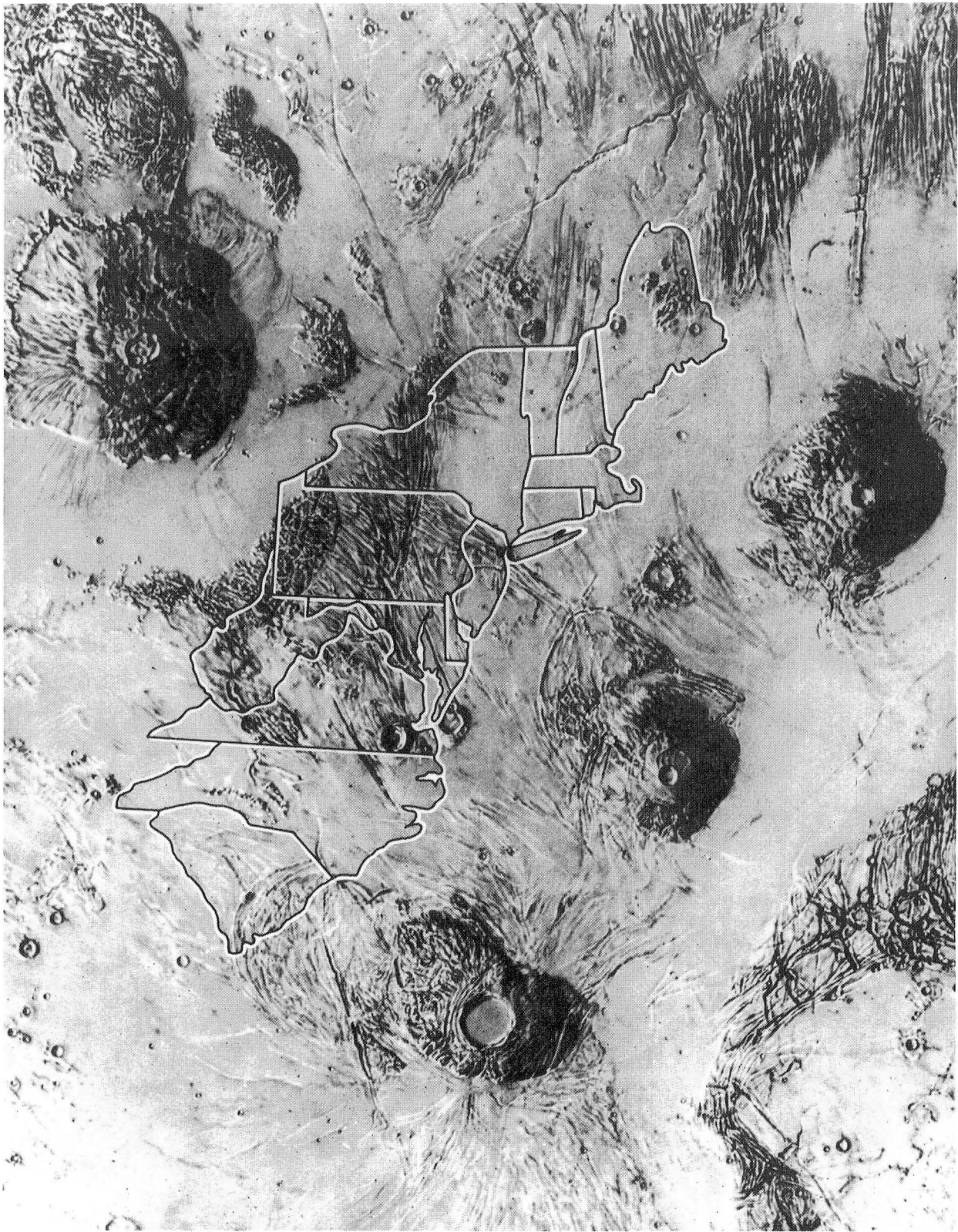
VALLES MARINERIS

Valles Marineris, the huge canyon of Mars, would stretch entirely across the United States—a distance of about 5,000 kilometers (3,000 miles). It ranges up to 240 kilometers (150 miles) wide and 6.5 kilometers (4 miles) deep.



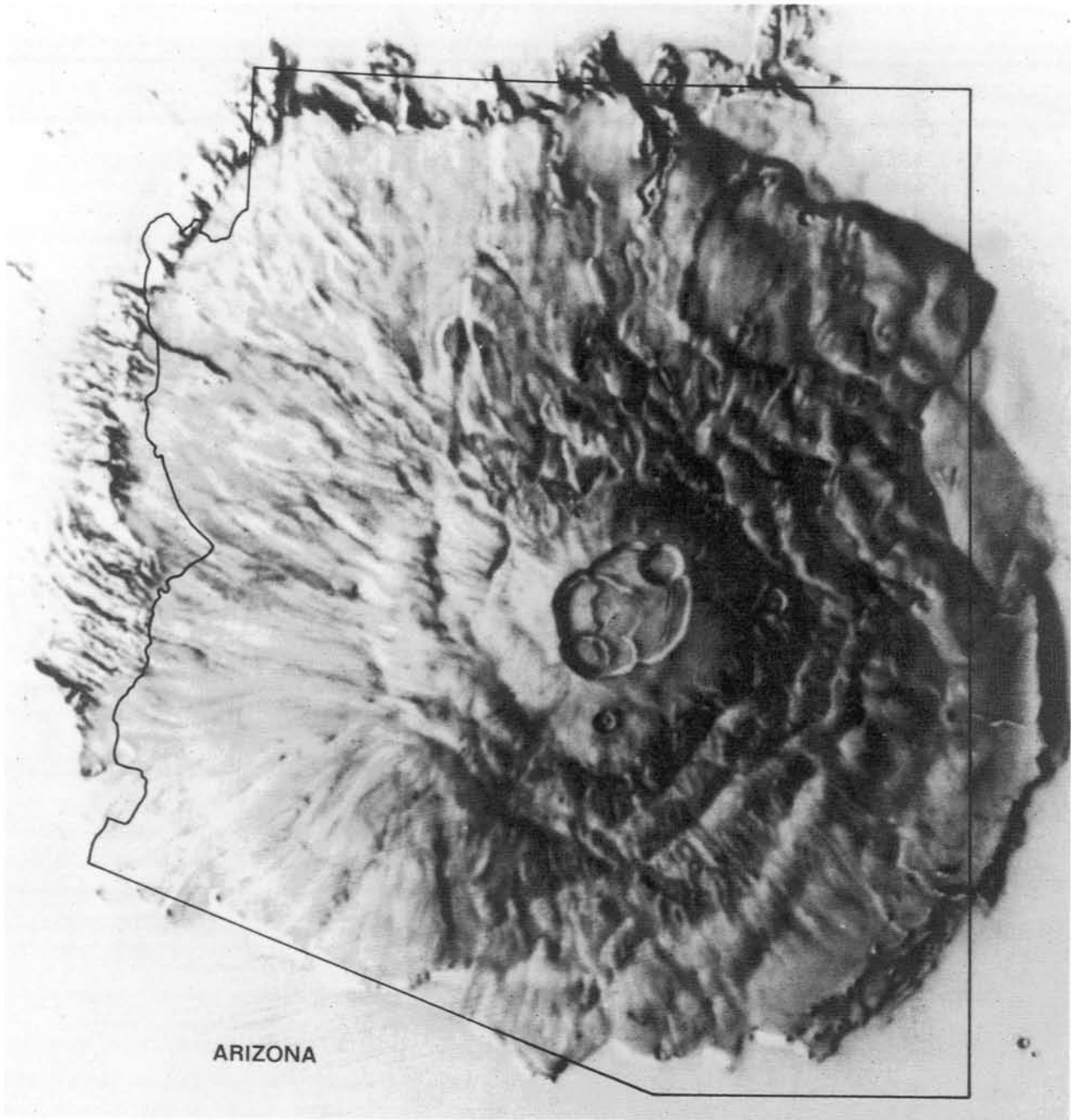
THE THARSIS RIDGE

The immense volcanoes in this airbrush map make up the Tharsis Ridge, an elevated area on the Martian surface. The volcanoes rise up to 26 kilometers (16 miles) in altitude. Their extent is indicated by the outline of the East Coast, which is shown at the same scale.



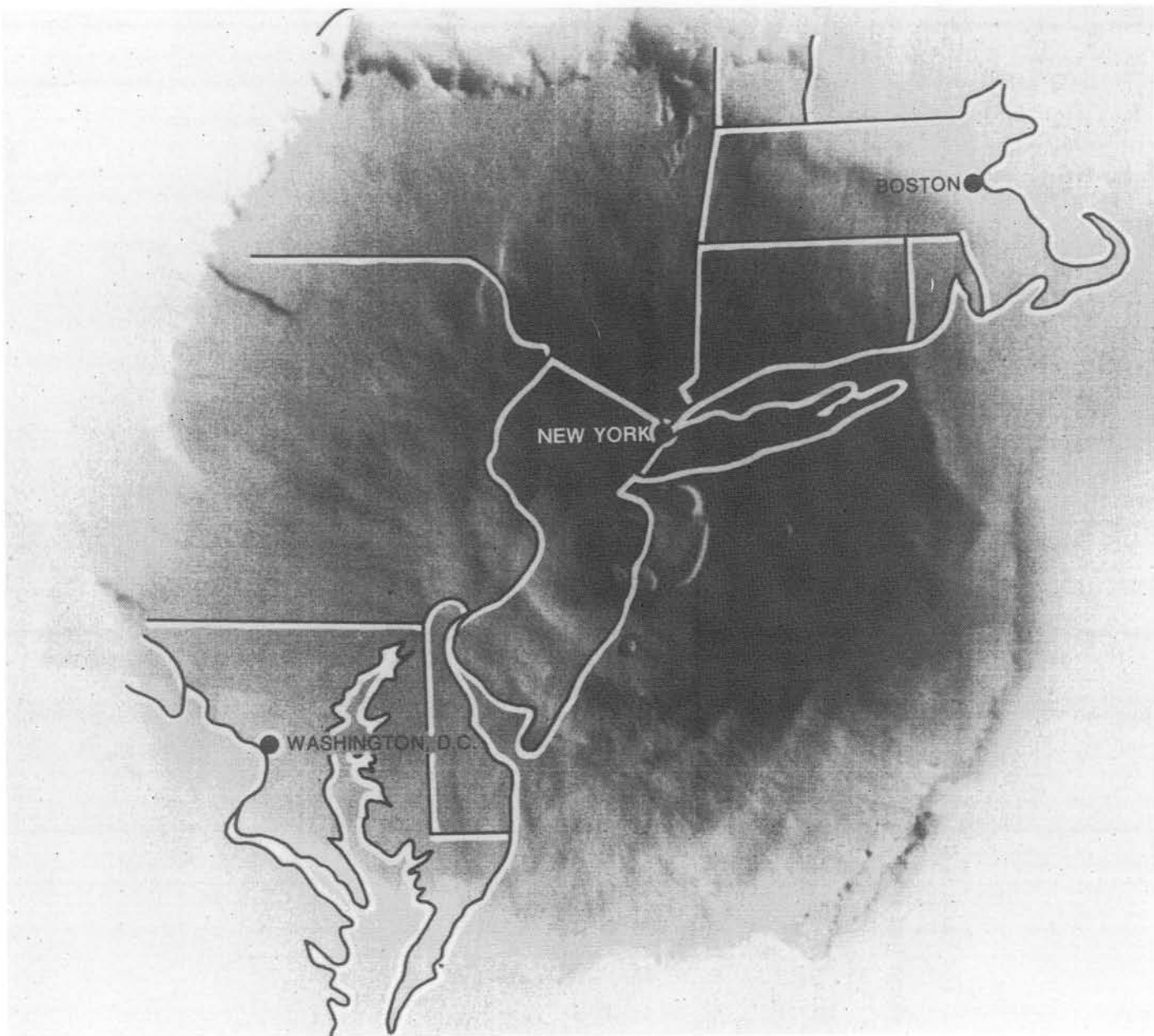
OLYMPUS MONS #1

Olympus Mons, the largest volcano on Mars, is the highest known mountain of any planet in the solar system. Approximately 650 kilometers (400 miles) wide, Olympus Mons rises 26 kilometers (16 miles) in elevation—almost three times the height of Mount Everest on Earth. Its immense size is indicated by this comparison with the state of Arizona. (This is an airbrush map version).



OLYMPUS MONS #2

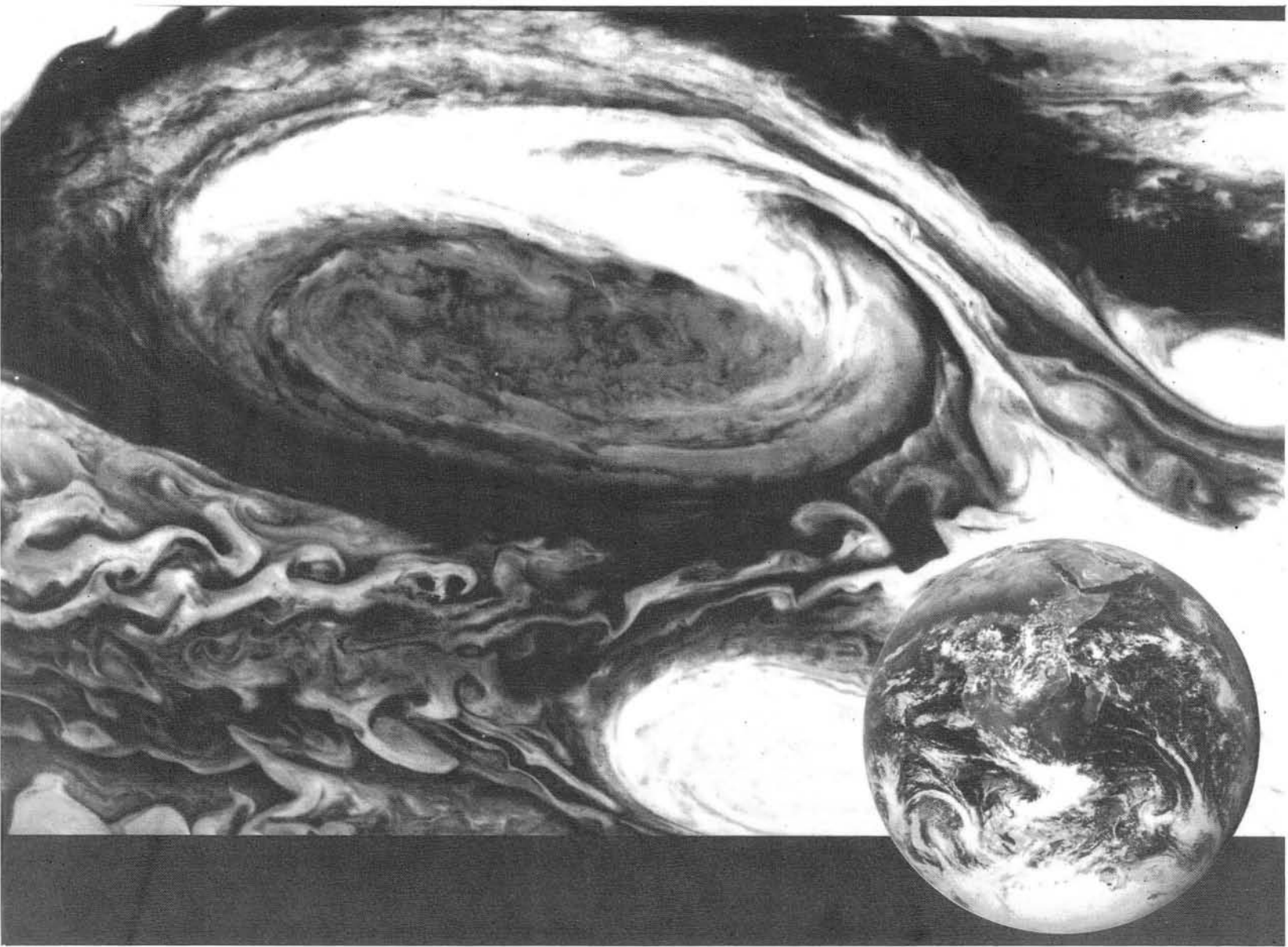
The huge Martian volcano Olympus Mons shown at the same scale as the Northeast United States.



83 H 208
83 HC 208

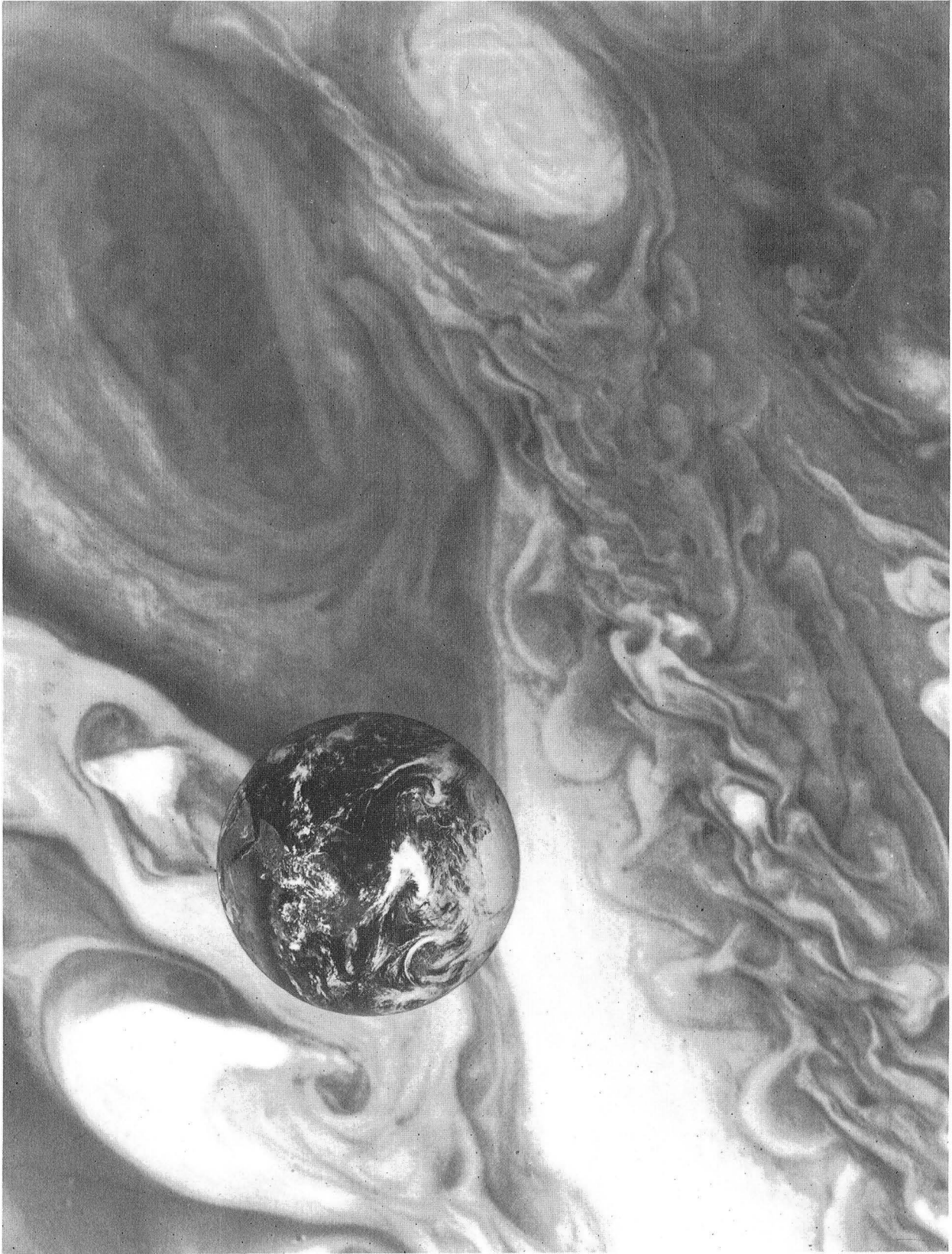
THE GREAT RED SPOT

The Earth is shown at the same scale as the Great Red Spot of Jupiter. The Red Spot is a huge storm that has been observed for hundreds of years in Jupiter's thick atmosphere.



CLOUDS OF JUPITER

The Earth seems to be serenely floating above the clouds of Jupiter in this photo composite. Since they are shown at the same scale, it is graphically apparent that many of the cloud features are as large as continents on the Earth. At the upper right is the Great Red Spot of Jupiter—a huge long-lived storm system.



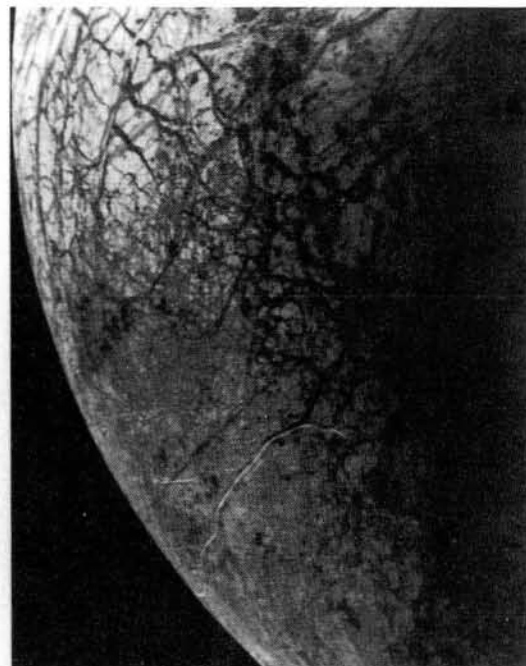
83 H 210
83 HC 210

JUPITER'S MOONS—CLOSEUP

These 4 views show the great surface variety present on Jupiter's large satellites. We see volcanic deposits on Io, ice fractures on Europa, grooved terrain on Ganymede, and impact basins on Callisto. The relative ages of these surfaces range from Io, the youngest, through Europa and Ganymede, to Callisto, the oldest.



IO

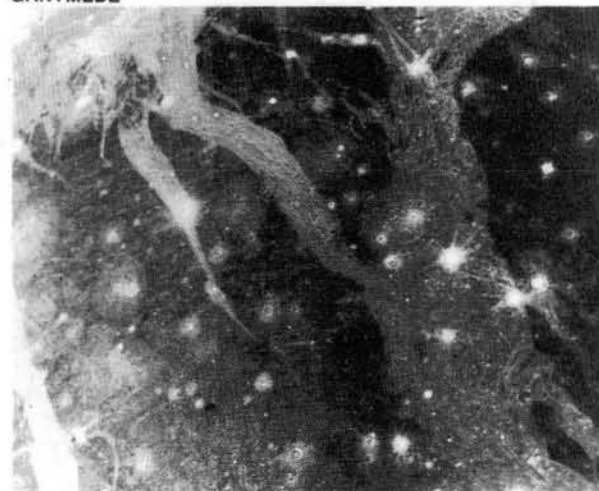


EUROPA



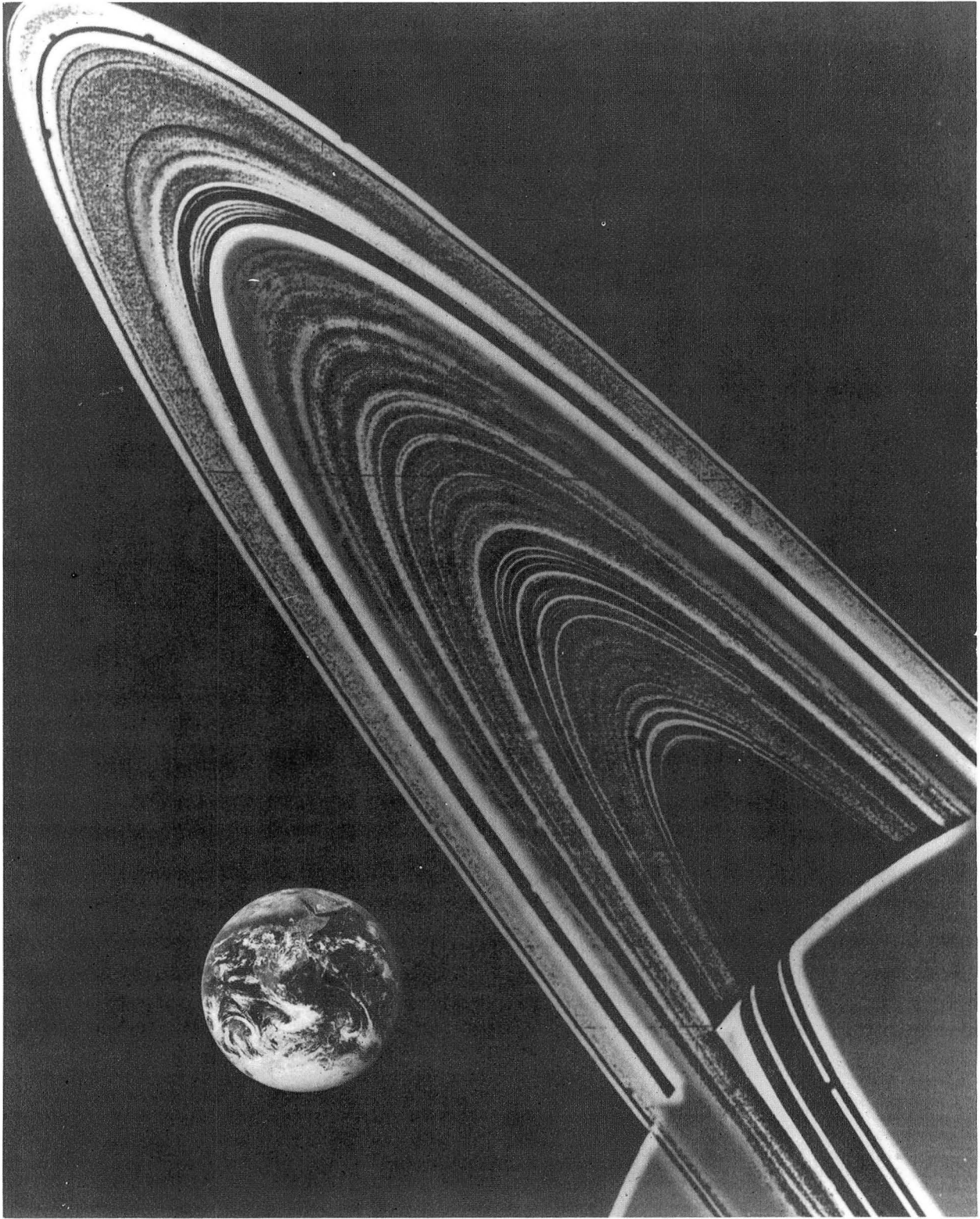
CALLISTO

GANYMEDE



THE RINGS OF SATURN #1

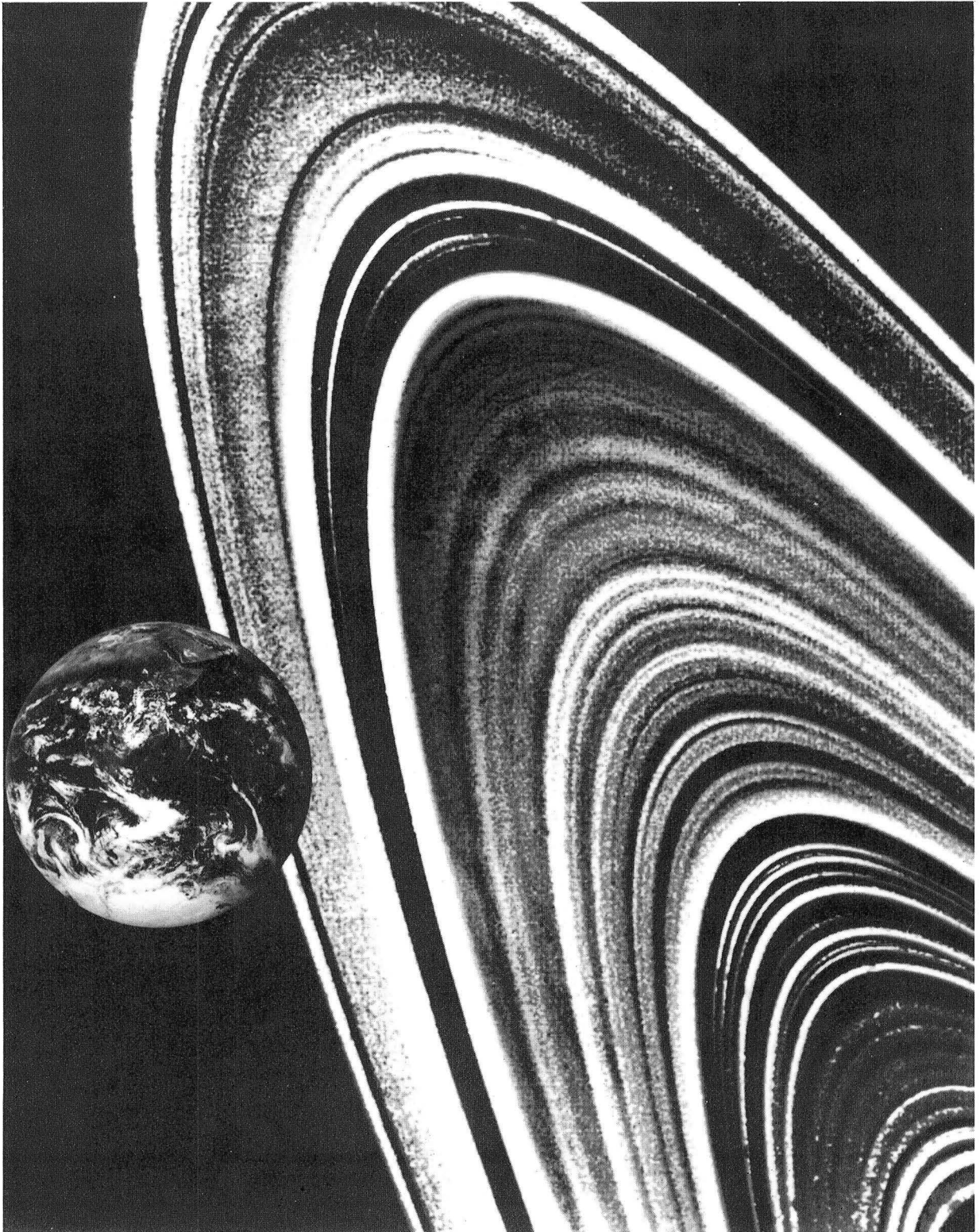
The Earth is shown at the same scale as the rings of Saturn. Although the brighter rings have a width about 5 times the Earth's diameter, their thickness is little more than a hundred meters (a hundred yards).



83 H 211
83 HC 211

THE RINGS OF SATURN #2

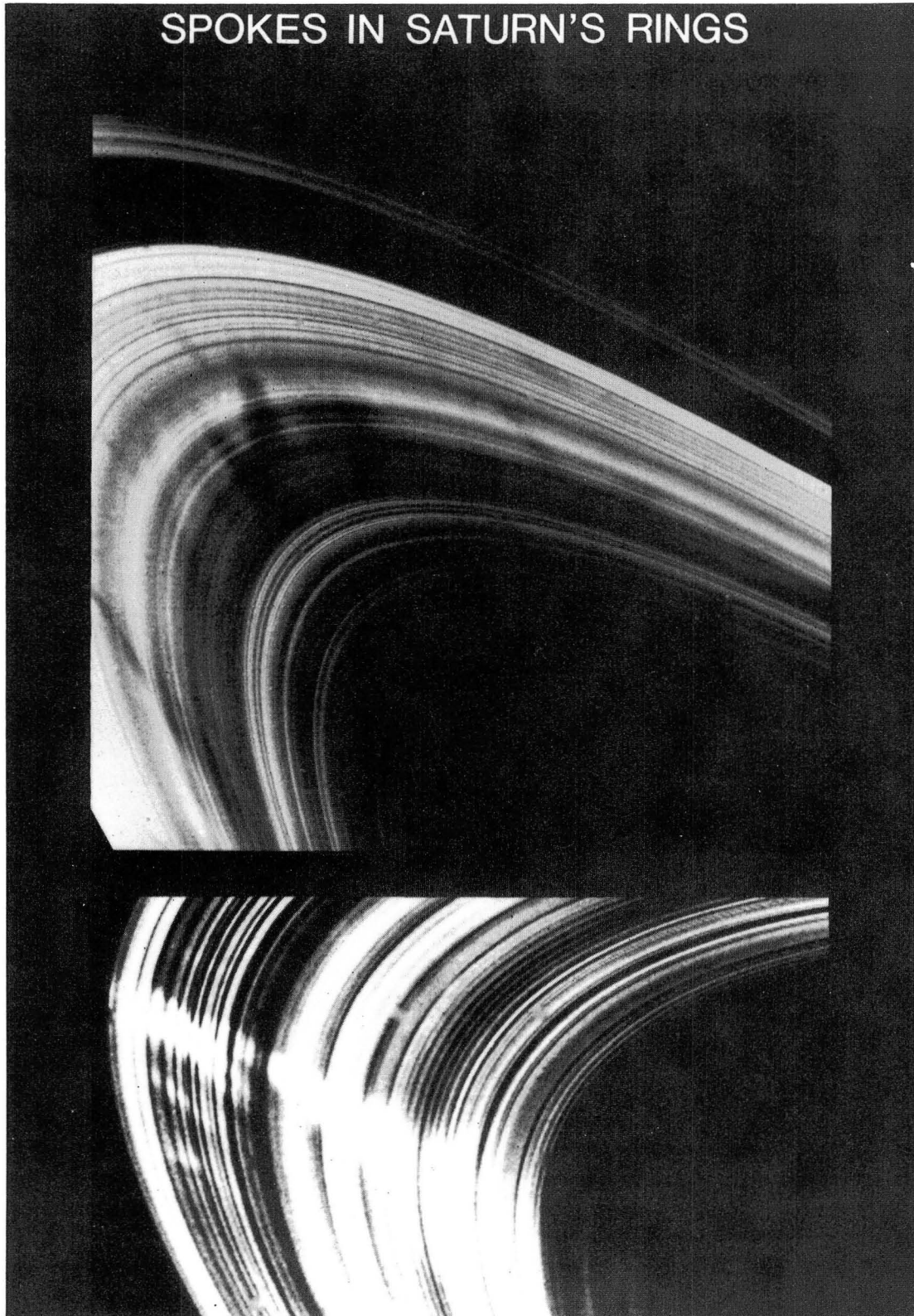
The Earth shown at the same scale as the rings of Saturn.



SPOKES IN SATURN'S RINGS

Spokes in the rings of Saturn appear to form and dissipate as they move around the rings. They may appear bright or dark, as shown here, depending upon the direction from which they are viewed. It is thought that the spokes may be composed of very fine particles levitated above the main ring plane by electromagnetic forces.

SPOKES IN SATURN'S RINGS



THE SURFACE OF MARS

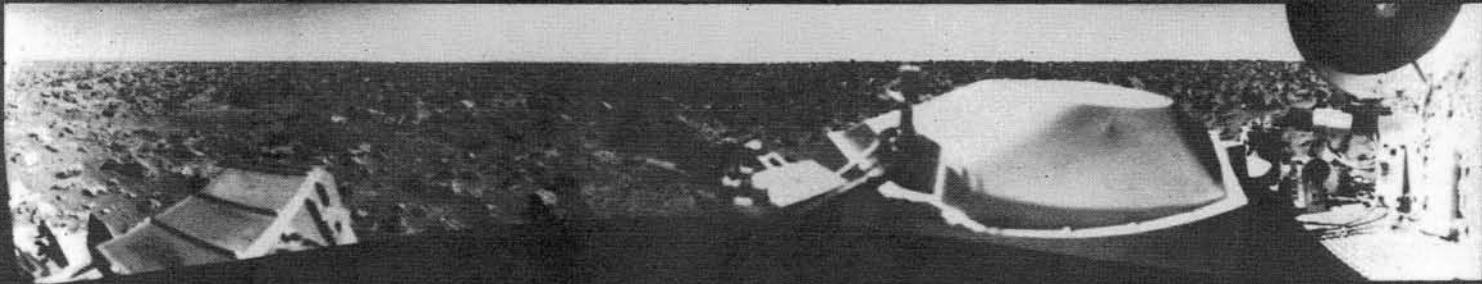
Panoramic views of the surface of Mars from the Viking 1 and 2 lander spacecraft.

MARS

VIKING 1



VIKING 2



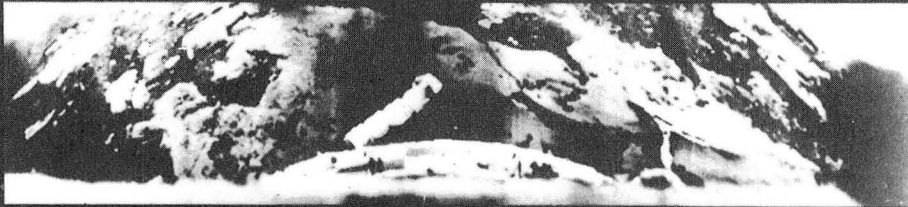
THE SURFACE OF VENUS

Wideangle views of the surface of Venus from the Soviet Venera 9, 10, 13, and 14 lander spacecraft.

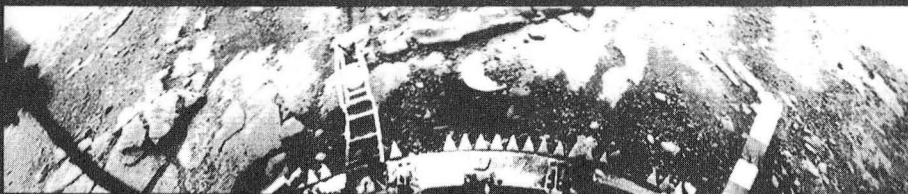
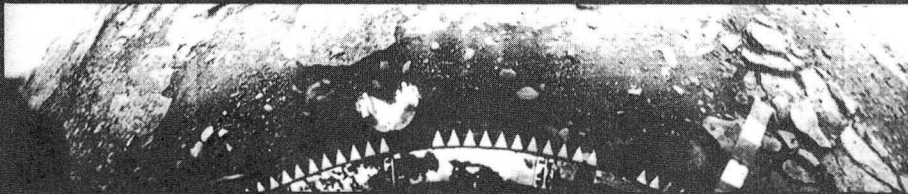
VENERA 9



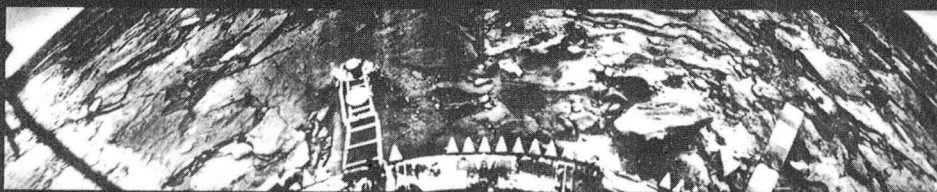
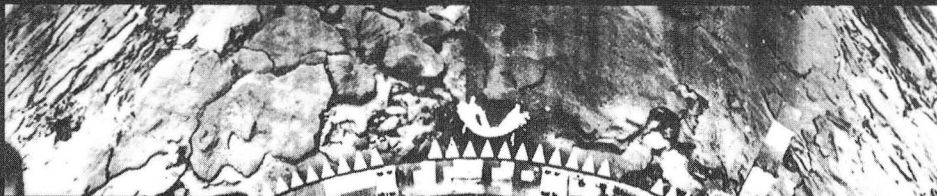
VENERA 10



VENERA 13



VENERA 14

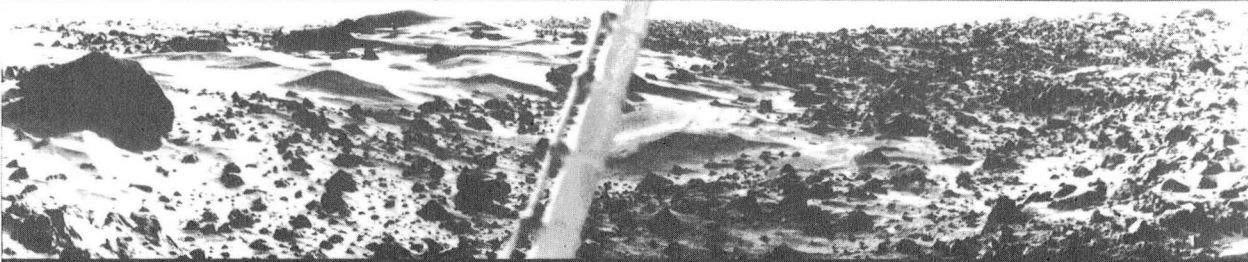


THE SURFACES OF MARS AND VENUS

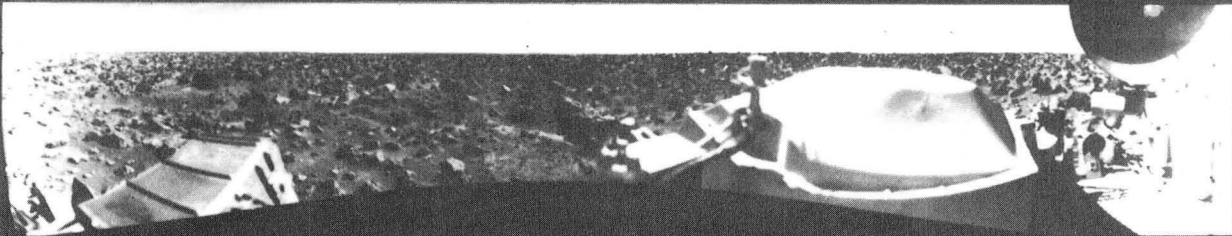
This comparison shows panoramic views of the surface of Mars from the American Viking spacecraft and the surface of Venus from the Soviet Venera spacecraft.

MARS

VIKING 1

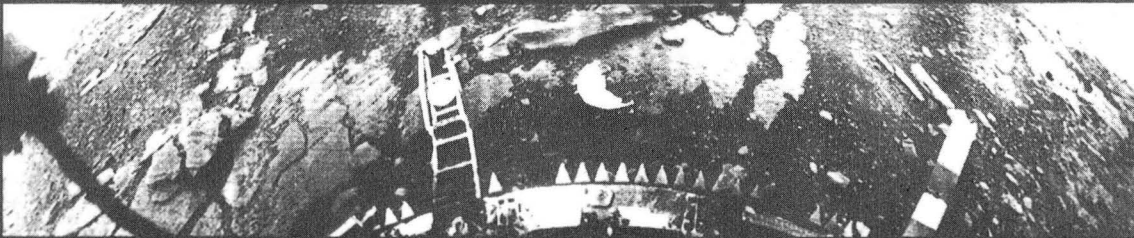


VIKING 2

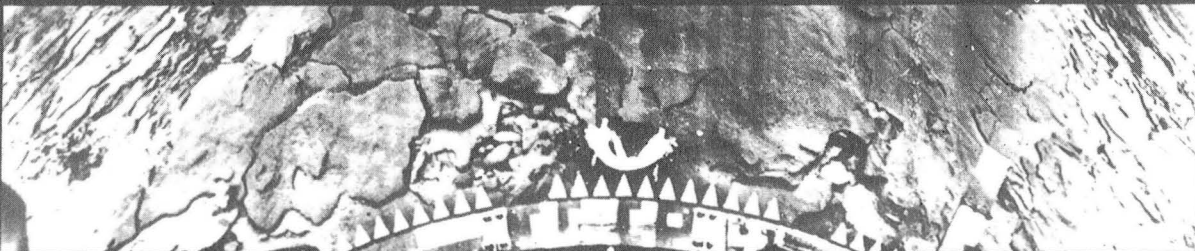


VENUS

VENERA 13

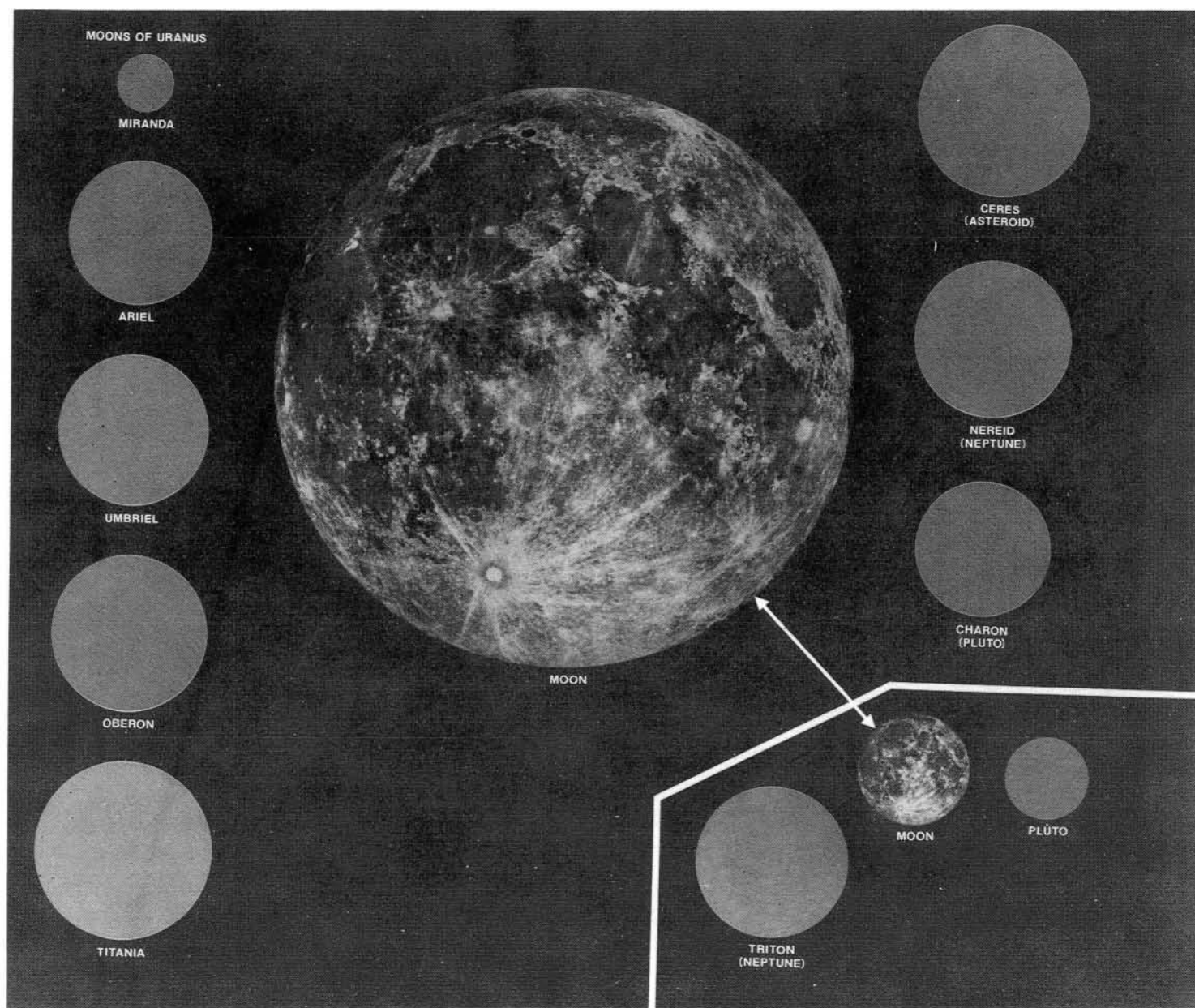


VENERA 14



OTHER DESTINATIONS

Other possible destinations of exploratory spacecraft are shown at the same scale as the Earth's moon. (Sizes are the best determination as of 1980). They include: the moons of Uranus (Miranda, Ariel, Umbriel, Oberon, Titania), the moons of Neptune (Nereid, Triton), the small planet Pluto and its moon (Charon), and the largest asteroid (Ceres).
(Photo of Earth's moon courtesy of Lick Observatory).



BIBLIOGRAPHY*

Books

- Beatty, J.K., O'Leary, B., and Chaikin, A., editors, *The New Solar System*: Sky Publishing Corporation, Cambridge, Massachusetts, and Cambridge University Press, New York, 1981.
- Carr, M.H., *The Surface of Mars*: Yale University Press, New Haven, 1981.
- French, B.M., *The Moon Book*: Penguin Books, New York, 1977.
- Gallant, R.A., *National Geographic Picture Atlas of Our Universe*: National Geographic Society, Washington, D.C., 1980.
- Glass, *Introduction to Planetary Geology*: Cambridge University Press, New York, 1982.
- Guest, J., Butterworth, P., Murray, J., and O'Donnell, W., *Planetary Geology*: John Wiley & Sons, New York, 1979.
- Hartmann, W.K., *Astronomy: The Cosmic Journey*: Wadsworth Publishing Company, Belmont, California, 1978.
- King, E.A., *Space Geology: An Introduction*: John Wiley & Sons, New York, 1976.
- Lowman, P.D., *Lunar Panorama*: Weltflugbild Reinhold A. Mueller, Zurich, 1969.
- Murray, R., Malin, M.C., and Greeley, R., *Earthlike Planets*: W.H. Freeman, San Francisco, 1981.
- Short, N.M., *Planetary Geology*: Prentice-Hall, Englewood Cliffs, N.J., 1975.
- Taylor, S.R., *Lunar Science: A Post-Apollo View*: Pergamon Press, New York, 1975.

Periodicals

The listed issues of the following periodicals have one or more major articles covering the topics named. National Geographic is written on a non-technical level, Scientific American on a technical but non-specialist level, and Science on a high technical level for specialists. Papers

published in Science are generally original research reports.

National Geographic: February 1969: The Moon, K.F. Weaver

February 1973: Journey to Mars, K.F. Weaver

Sept. 1973: Three articles summarizing the Apollo lunar missions.

January 1980: Articles on the Voyager flyby of Jupiter

July 1981: Saturn: Riddles of the Rings, R. Gore - summarizes the
Voyager flybys of Saturn

Scientific American: September 1975: Special issue on the solar system

March 1978: The surface of Mars, R.E. Arvidson et al.

January 1980: Volcanoes of Io, L.A. Soderblom.

November 1981: Rings in the Solar System, J.B. Pollack, J.N. Cuzzi.

Science: Feb. 23, 1974: Issue devoted to Pioneer-Venus results from Venus orbital
mission

March 29, 1974: Issue devoted to initial Mariner 10 results from Venus
fly-by

June 1, 1979: Issue devoted to Voyager 1 encounter with Jupiter and
satellites

Nov. 23, 1979: Issue devoted to Voyager 2 encounter with Jupiter and
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April 10, 1981: Issue devoted to Voyager 1 encounter with Saturn and
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Jan. 29, 1982: Issue devoted to Voyager 2 encounter with Saturn and
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